MODERN ORCHARD PRACTICES

BY

M. B. DAVIS

WITH

A SECTION ON INSECTS AFFECTING THE APPLE

By W. A. ROSS, Entomological Branch

AND

A SECTION ON APPLE DISEASES

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DOMINION EXPERIMENTAL FARMS

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A Nova Scotia apple tree, 150 years old and "still going strong."

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DEPARTMENT OF AGRICULTURE

BULLETIN No. 129—NEW SERIES

MODERN ORCHARD PRACTICES

Horticultural science is to-day making rapid strides in the solution of problems upon which light has long been wanting. Scientific research is unearthing a wealth of material, much of which offers practical solutions or, at least, suggestions for some of the difficulties in profitable orchard management. Pruning recommendations to-day are radically different from those of a few years ago, and the new recommendations are based on experimental results. The much discussed fertilizer problem is now being studied from a plant physiological and biochemical standpoint, which, together with external observations, has enabled us to see this problem in an entirely new light, and although definite rules cannot, and perhaps never will, be made, on account of differences of location and types of soils, many helpful and suggestive recommendations have been the outcome.

Fruit bud formation is another phase of recent study and its close relation and interdependence upon fertilizer practice and pruning make it necessary to treat these three problems almost as one and he who would understand one must have a knowledge of the others. The day of definite instructions applicable to all districts and sets of orchard conditions has passed. The most one can hope to accomplish is to aid the orchardist to grasp the principles underlying successful orchard management and to indicate these principles by citing a few typical examples of entirely different conditions and leave to the grower himself the application of these principles to his own conditions.

TRAINING THE YOUNG TREE

One of the most important operations in the management of a young orchard for the first two or three years after planting is the proper training of the trees.

Fig. No. 1. Central leader type.

Two-year-old apple tree marked For pruning

Three-year-old low-headed apple tree

The word " training " here is used in distinction from the word " pruning," for the object of any pruning practice adopted for the first few years of the life of a tree is primarily to obtain a tree of proper form and shape and is essentially a training process, whereas pruning proper is conducted primarily to maintain proper functioning of the tree as a fruit producing or commercial proposition.

There are, in general, three main types of tree which may be chosen as ideals. These are the central leader or pyramidal form, the open centre and the modified central leader.

Fig. No. 2. Open centre type of tree.

Central Leader Type.—The first mentioned, namely, the central leader type, is probably the strongest and consists of a central leader or main stem growing to the full height of the tree, from which lateral branches radiate. (See fig. 1). Such a tree, although capable of withstanding much strain, has the disadvantage in later years of becoming too shaded in the lower portions, with resultant loss of many limbs due to lack of leaves and consequent food supply. It is, moreover, apt to become too tall in proportion to its spread, resulting in difficulty with regard to spraying, in addition to a comparative reduction in fruiting surface.

Fig. No. 3. Modified leader type of tree.

Open Centre Type.—The second type has the disadvantage of being a very weak tree, for in this type the main branches originate from almost the same locality on the main trunk and generally split apart, often with complete loss of the tree. This style of tree, however, offers greater possibilities for the maintenance of a large fruiting surface than the former and, as the centre is comparatively open and the tree more spreading in habit, it is generally better for the production of high-coloured fruit than is the central leader type. (See fig. 2).

Fig. No. 4. All the branches in this tree are sharpangled.

Modified Central Leader.—The third type is a modification of the two previous ones and is recommended in preference to either. In this type the central leader is allowed to grow to a height of about three feet so that the main scaffold limbs of the tree can be properly spaced on it without originating from the same locality. After the main limbs have been obtained, the central leader is cut out and the tree from that time takes on the form of an open-headed or open centre tree, giving the grower the combined advantages of the open centre and the central leader types.

Fig. No. 5. The same variety as in Fig. No. 4, but forming a better crotch angle.

SELECTION OF CROTCHES A VITAL FACTOR

Having decided upon the form or type of tree to be grown, attention must then be paid to the selection of the main or scaffold limbs, generally about five or six in number. In this connection, the angle at which the branch leaves the main trunk is a determining factor. Branches which leave the main trunk at an acute angle form weak crotches and will easily split. These should be cut out and those branches which form almost a right angle with the main trunk selected to form the original framework or scaffold of the young tree. The avoidance of these sharp-angled or weak crotches is a vital factor in all pruning practice, as a little attention paid to this one point may in future years avoid the loss of a large number of trees, due to splitting.

HEADING BACK THE YOUNG TREE TO BE PRACTISED WITH CAUTION

During the first few years of a tree's life it is necessary to practice annually some heading back, but in many instances in the past this has been very largely overdone, with a resultant delay in fruiting and a general weakening of the tree. Although, when a tree is severely cut back, it may produce new shoots of greater length than if it had not been cut back, it is a mistake to assume that it is making a greater growth than unpruned trees. In recent experiments at the Central Farm and elsewhere, it has been found that trees cut back severely each year have not made as great a girth or as large a total growth as those not pruned at all. Severe heading back has a devitalizing effect and only delays the time when the tree will commence to bear. Some pruning and possibly heading back, however, is necessary, for to leave a tree unpruned for any length of time would result in too thick a top and probably such a poorly pruned tree that it would require too drastic treatment later in its life to rectify the earlier mistake of neglect of pruning. For the first two or three years the object of pruning is to train the tree and induce the growth of properly spaced lateral branches, which in future years will produce fruit bearing wood. This is accomplished by a combination of light heading back and cutting out, as will now be described.

THE FIRST YEAR AFTER PLANTING

Commencing with the second spring, or the first year after planting, the tree is pruned so that the central leader will maintain the lead, and from two to five other branches should be selected, as previously mentioned. All other branches are removed and the remaining selected ones are cut back a short distance, cutting the weaker ones the least. As these main branches will probably have some laterals on them it may be advisable to remove some of these at this time if they are not properly spaced. At this juncture it might be mentioned that the habit of the variety in question will often decide much of the treatment to be given. For instance, with some varieties which are prone to produce very long, rangy growths, with few laterals, more heading in and careful handling are required than with one which naturally produces many laterals, in which case the treatment becomes more of a system of thinning out. With those sorts producing the long, rangy growth, much can often be gained by a combined system of summer and spring pruning. Early in summer, say mid June, the branches cut back in the spring will have put forward considerable growth and as soon as this growth has reached a stage where laterals can be spaced on it, pinch back the terminal growth which will force out laterals close to the point of pinching and thus a season may sometimes be gained. But it must be borne in mind that this pinching should be done early and is only recommended for varieties or trees producing long growths with few lateral branches, thus necessitating rather severe heading in under ordinary procedure.

It is the common practice to let these terminal growths grow until the following spring, or even for two years, when it is found necessary to remove a foot or more of new wood in an endeavour to force out lateral growths. This means a waste of energy, for one could have cut back to that same point in early summer without reducing the leaf surface of the tree to any extent. The idea is to economize in tree energy, as constant large reductions of leaf and wood area not only delay the age at which the tree will fruit, but reduce its ultimate size and vigour.

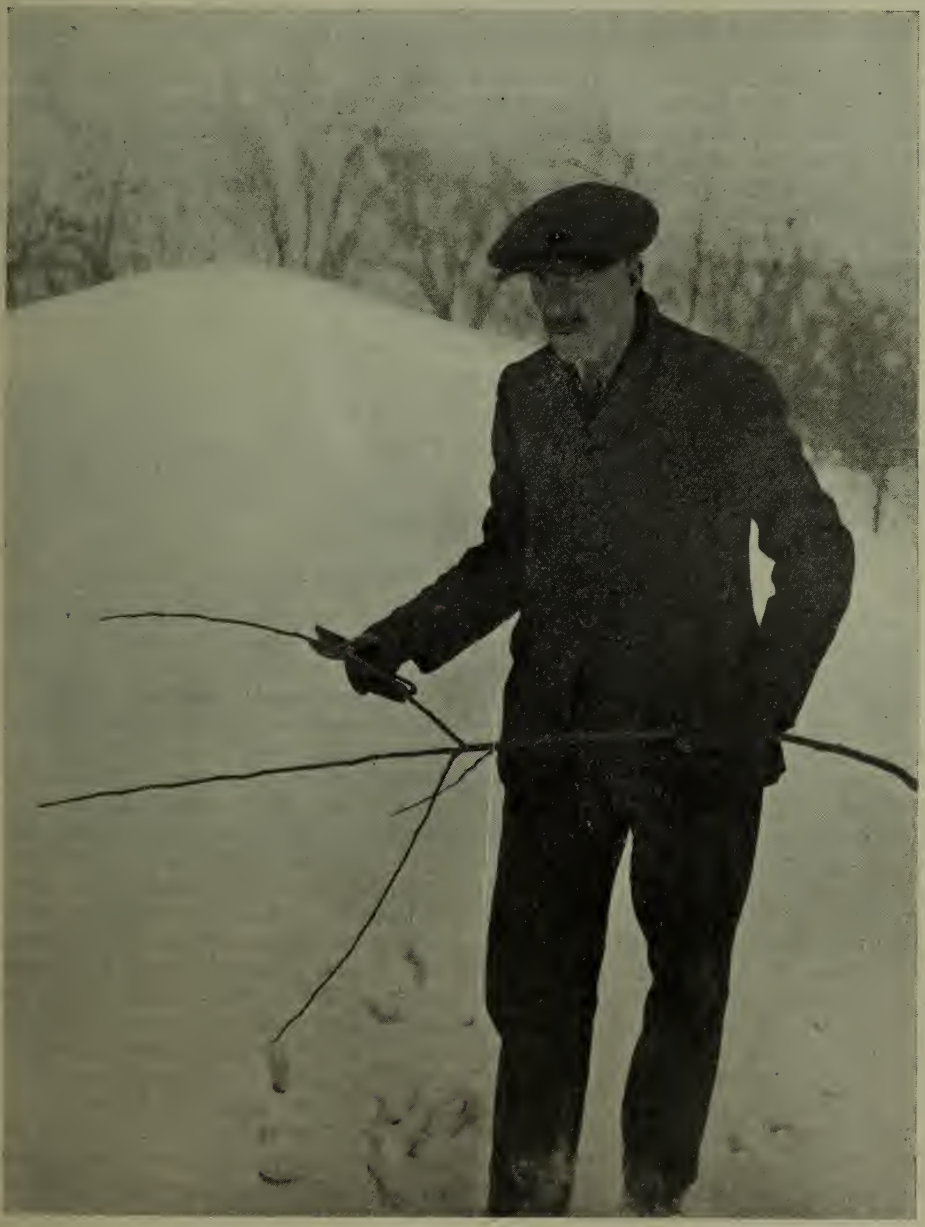


Fig. No. 6. Showing a lateral branch leader of the same length, the lateral being cut to allow the leader to develop and thus avoid a weakened crotch.

THE SECOND SPRING AFTER PLANTING

By the following spring, each of the branches pinched back in summer will probably have a number of laterals attached to them. All these laterals but one for each main branch are removed, thus leaving twice as many branches as there were the previous spring. Select, of course, the best spaced and strongest branches in every case. In selecting these laterals make certain that the lateral is not cut the same length as the main branch, or the result will be weakened crotches. This is illustrated in Figure No. 6.

THE THIRD SPRING AFTER PLANTING

The orchard has now arrived at the summer of the third year after planting and should be well established and in good condition. A considerable amount of new growth will have been put out and again it will be advisable to look to the establishment and placing of lateral branches. This should be accomplished with as little top removal as possible, so, if the tree shows a tendency towards rangy growths devoid of laterals, the practice of early summer pruning may again be adopted. During this third summer lateral branches formed the previous season should produce sub-laterals and thus be building up a large fruiting area for future performance.

COMMENCING WITH THE FOURTH YEAR

Commencing with the fourth spring it should only be necessary to clip back too long or rangy laterals and thin out the undesirables and cross branches. During the summer attention should be paid to too strong growing branches, suppressing the stronger to give the weaker an opportunity to develop. Heading in or top removal should be kept down to the utmost minimum from this time on, as the tree should now be approaching fruiting age.

COMPLETION OF THE TRAINING AGE

As the tree has by this time (the beginning of the fifth season) almost passed through its training period, pruning practices should be altered slightly to conform with the desired functions of the tree, namely vegetative extension and fruiting. Properly to understand the principles underlying any system of pruning designed to maintain the fruitfulness of a tree, some idea must be gained as to the relation which exists between a pruning practice and the nutrition of the tree. This involves a consideration of fertilizer practice. The reader's attention will therefore now be turned to a study of *the relationship which exists between fertilizer practice, pruning and profitable fruitfulness of the tree.*

In the preceding pages of this bulletin, it has been shown that to produce a tree of desired type and form, one should guard against swinging from severe pruning to absolutely no pruning for a considerable period, the sequel of which would ultimately be a rather too severe heading back and cutting out to correct past neglect, with a possible consequent upset in the balance between the supply of nitrogen and carbohydrates. In short, more or less severe heading back and thinning out during the first four years after planting may be necessary to mould the form of the tree and may be practised without economic loss of vigour. After that, however, severe annual pruning should be discontinued and trees that are bearing annually should receive light annual pruning, sufficient only to maintain symmetry, to prevent too long or rangy growth and to prevent the establishment of long limbs with growth only at the tips. The principles which lie behind these pruning recommendations will be discussed later in this bulletin. In the meantime let us consider the status of orchard fertilization.

Science has given us some general principles which should materially assist many in reducing their fertilizer bills. Kraus and Kraybill have shown

(1) that there must be a correct balance among nitrogen, carbohydrates and moisture before we can get fertilization and vegetation combined; (2) that an abundance of moisture and nitrogen without an available supply of carbohydrates results in weak and unfruitful plants; (3) that an abundant supply of nitrogen and available carbohydrates gives increased vegetation and non-fruitfulness; and (4) that lack of nitrates with available carbohydrates is similar in results to an abundant nitrogen supply and a low amount of carbohydrates, that is, weakened and unfruitful plants result.

There must exist, therefore, an available supply of carbohydrates, available moisture and a sufficient, but not an over abundant, supply of nitrates, if fruitfulness and vigour are to be obtained. In short, it is not so much the absolute amount of each fertilizing element present that counts, as their proportion to one another. This is pointed out to show how easy it is to upset the proportion between nitrates and carbohydrates and thus throw trees out of bearing.

Nitrogen is taken up by the tree from the soil in the form of nitrates and, without an available supply of water, nitrates, even though abundant, cannot be utilized by the plant, as they enter the root in solution. It is easy to conceive, therefore, of a condition where moisture might be the limiting factor and not nitrogen or carbohydrates. Carbohydrates on the other hand, are complex substances, such as starches, sugars and natural gums, composed of carbon, hydrogen and oxygen in varying proportions, which are manufactured by the leaves of the plant from the constituents entering the roots in the form of solution and from the carbon dioxide taken in by the leaves from the air.

Unless artificially supplied to the soil, the plant is dependent for its nitrogen upon processes known as nitrification, wherein unavailable supplies of nitrogen are changed into nitrates and thus made available for plant consumption. Nitrification requires a comparatively warm and well aerated soil. As trees start into growth early in spring before the soil temperature is relatively high, it is conceivable that nitrification processes are at that time not very rapid and, except on soils rich in nitrogen, the actual supply available for the plants at that time of year is probably insufficient for the plant's needs.

Carbohydrates are manufactured by the leaves and it should be here added that any quantity of carbohydrates in excess of what is required for the immediate consumption of the tree is stored in the form of starches in that portion of the tree close to the leaves which manufactured it. This is the condition of healthy trees during the winter, namely, stored reserve supply of carbohydrates within the plant tissues. Although there is some storage of nitrogen, practical experiments indicate that the tree in early spring calls upon the soil for a further supply of this element.

Soil nitrification being slow in the spring and slower still in a cold, wet spring, early applications of nitrate of soda often result in increased productiveness. Without available nitrogen at this time of year, the carbohydrates are in too large proportion to the nitrates with resulting suppression of both vegetation and fruitfulness. Not only is the actual ratio existing between the available nitrates and carbohydrates out of proportion, but the manufacture of carbohydrates in the immediate future might be in danger of being limited, due to lack of available nitrates. Carbohydrate manufacture is dependent, of course, upon the leaves, leaf expansion is largely influenced by nitrogen supply, and fruit bud formation is dependent upon an available supply of carbohydrates at the critical period, so here is another way in which a shortage of available nitrates at the critical period might prevent proper fruit bud formation. Although an early application of nitrogen will give desired results it is not to be presumed that applications made in mid-summer or late spring will do likewise. At these seasons soil nitrification is at its height and further applications of nitrates would probably result in increased vegetative growth of the tree, and if the supply of nitrates continued to be abundant or in excess as compared

with the carbohydrate content of the tree, late vegetative growth with resultant winter injury may take place. It is not unusual to see trees injured by the application of nitrates, not that the nitrates have a toxic or deleterious effect upon the plant, but the presence of too much available nitrogen late in the season causes the tree to enter the winter with unripened wood, with subsequent winter injury showing up the following year.

Where nitrates have not been used and trees in spring present considerable yellow leaf and an unthrifty appearance, recovering later in the season, an application of five pounds of nitrate of soda is not out of place. These early applications of nitrogen may materially assist in maintaining annual bearing

(Courtesy of Agricultural Experimental Station, Storrs, Conn.)

A high headed tree badly in need of repair.

by establishing a correct balance between carbohydrates and nitrogen supply. In orchards grown on sod, where little nitrogen has been supplied, an application of nitrates will work wonders in productiveness. In such instances the trees already have an abundant supply of reserve carbohydrates, but lacking nitrogen are unable fully to utilize these reserves for vegetative extension and fruitfulness.

It might be well to point out here that this balance could, temporarily, at least, be obtained by severe pruning, for by such a practice the leaf area is reduced with a consequent reduction in available carbohydrates, thus relatively increasing the nitrogen carbohydrates ratio. Probably in the case of older trees which are barren, a moderate heading back under such circumstances, accompanied by a light application of nitrates would be a better means of establishing the proper balance. All this tends to illustrate that nitrogen is not only essential

for vegetative extension, but for fruitfulness as well; that there is close relationship between vegetative extension and fruitfulness and that the two are not diametrically opposed as has too often been thought.

At this juncture, reference should again be made to the abandoned practice of yearly heading back. What is the explanation of the poor vigour and delayed fruitfulness of trees grown under this system? Simply that in removing such large quantities of wood a considerable amount of carbohydrates as well as the future means for its manufacture were removed and a condition of relatively low carbohydrate content and abundant nitrogen supply resulted, with necessarily reduced vegetative vigour and delayed fruitfulness.

(Courtesy of Agricultural Experimental Station, Storrs, Conn.)

The same tree as shown on page 14, after pruning. This tree should have the top removed as shown by the white line.

We have seen then that there must exist a correct balance between the nitrates and carbohydrates; that this may be re-established by the addition of nitrate to the soil in early spring, and by early cultivation; or that by reducing the top of the tree, thus lowering relatively the carbohydrate nitrogen relationship we can arrive at the same end, at least temporarily. Thus is established the close relationship between fertilizer practice and pruning.

MAINTENANCE OF FERTILITY

In the few preceding paragraphs, the relation between nutrition and pruning has been pointed out. This involved a discussion as to the rôle of nitrate of soda, so that it will not be necessary again to repeat what has already been said

in that connection. Attention will now be confined to the use of fertilizers other than nitrates and to the use of cover crops, which have an important bearing on the maintenance of fertility in the majority of orchards.

Although nitrate of soda appears to have given fairly good universal results, the use of the two other commonly recommended classes of fertilizer, namely, phosphates and potash salts, has not met with such widespread success. It should not be inferred, however, that the use of phosphorus or potassium should on this account be discontinued. A brief resumé of orchard fertilizer practice in the past, together with present recommendations, will make this much clearer.

A brief survey of fertilizer recommendations and treatments generally given to orchards prior to 1914 reveals the fact that either manure was used or that complete fertilizers, containing about four per cent nitrogen, eight per cent phosphoric acid and four per cent potash, were largely used. Variations from these were either in the form of basic slag alone or a combination of some phosphatic fertilizer and a potassic fertilizer. Rarely, if ever, were nitrogenous fertilizers used in larger amounts or even alone. Such practice must have resulted in the comparative accumulation of the mineral elements of the soil and the comparative depletion of the available nitrogen. This was a general condition, with variation of course among individual orchards. In addition, in many orchards which had never been fed, nitrogen was of course also in deficiency and probably the most limiting factor. During the war, potash becoming unavailable, growers learned that they could get along for a time without this element of plant food. Then about 1919 there began the general use of nitrogen only, applied to orchards in early spring. The practical results were, of course, almost miraculous and there became a widespread belief that nitrogen was the only element of plant food necessary for orchard purposes. Experimental results from all over the country corroborated this and rarely, if ever, were phosphorus and potassium found to increase growth or production.

During the last few years many growers who formerly had derived excellent results from nitrogen alone have failed to get the same measure of response. Whether this is due to fertilizer treatment only or to other factors is, of course, a debatable question difficult of final solution.

Briefly, the situation prior to 1914, in most orchards, was deficient nitrogen and comparative excess of mineral elements. After 1920 the situation changed to satisfactory nitrogen conditions with increasing accumulation of nitrogen year by year and a gradual decrease of mineral elements.

We are now in a position to discuss and appreciate the significance of a piece of work performed in this Division and reported in our 1927 Report. This work with strawberries in sand cultures showed briefly that a balance between nitrogen and the mineral elements was very essential in plant nutrition. It showed further that, while excess minerals up to a very high concentration did not result in any increase in yield, it did not produce any ill effects. On the other hand slight excess of nitrogen resulted in reduced yields and noticeable injury.

The value of maintaining the available mineral supply is, therefore, important and as the nitrogen content of the soil increases so should the mineral content increase. This points to the possibility of overdoing the nitrogen applications when made alone. Just how long it is possible to apply nitrogen alone to an orchard depends upon (1) the rate of application, (2) the soil and (3) the past treatment of the soil. No single experiment or piece of research can answer this question, but it can be pointed out that there is a danger of overdoing the continuous use of nitrogen only. It should be further borne in mind that the more nitrogen applied the greater the drain on the mineral resources of the soil. Every pound of nitrogen used in plant nutrition requires a certain amount of phosphorus, potash and other minerals.

As pointed out earlier in this bulletin few experiments during the last decade have shown results from phosphorus and potash, but very recently some evidence seems to be filtering through here and there to show slight benefits from phosphorus at least.

This Division has been conducting some field experiments at Abbotsford, Que., on a sod mulch orchard of mature trees which, previous to our treatment, had not received much in the way of fertilizers.

While it is yet too early to judge by the results of yields, growth results and girth increases serve as a good indicator of the response of the trees to the different treatments. To date there has been a distinct increase in girth on the plots receiving all three elements of plant food, as compared with those receiving nitrogen only. As girth increase has been shown to be indicative of and closely linked with the ultimate bearing possibilities of the tree, these complete fertilizer plots should eventually distinctly outyield the nitrogen-only plots.

In addition to the field work, investigations with strawberries and apple trees in sand cultures have led to the following formula for an orchard fertilizer, which we feel meets the needs more fully than either the old 4-8-4 mixture or the single element policy. This mixture consists as follows: 4 pounds nitrate of soda, or the equivalent, 2 pounds acid phosphate or its equivalent, and 1 pound muriate of potash or its equivalent. This works out to about a 9-5-7 mixture. The rate of application would depend upon the age of the tree, but for full grown trees, planted not more than sixty to the acre, about eight to ten pounds of the above mixture per tree should prove sufficient. Smaller trees or closer planting would have to be handled in proportion to the above.

MANURE VS. COMMERCIAL FERTILIZERS

If there is one part of the farm where commercial fertilizers can be used to advantage it is in the orchard. Here it is possible to make up for the lack of humus of the fertilizer by the use of cover crops or mulch. Results from past work have clearly demonstrated the fact that commercial fertilizers, when properly used in conjunction with these, will give as good results as the same amount of plant food supplied in the form of manure. In fact, if manure alone is used, the question of a sufficient supply of nitrates at the critical period in spring may not be solved, for the nitrogen in the manure is not in as readily available a form as it is in nitrates. When manure is used, the time of high nitrate liberation is generally somewhat after the period when it may be first required, so that, briefly, it is recommended in orchard practice to depend upon the different forms of nitrogen, potassium and phosphorus as found in commercial fertilizers to supply the mineral elements of plant food.

THE QUESTION OF THE FORM IN WHICH TO PURCHASE FERTILIZERS

There are different forms of commercial fertilizers containing the three elements of plant food here discussed and, as there is considerable difference in their value, some attention should be paid that question.

Generally speaking, orchardists should avoid the ready-mixed or complete fertilizers for orchard use, no matter how valuable they may have found them for other farm crops. The reason for this, aside from that of economy, is the question of availability and proper proportions. Nitrogen contained in the average complete fertilizer is not in a very quickly available form and, as it has been shown that nitrogen should be applied in a quickly available form early in spring, it will be readily seen that the complete fertilizer will not fill the bill. This one fact alone is sufficient to condemn the general use of complete fertilizers as purchased in the trade.

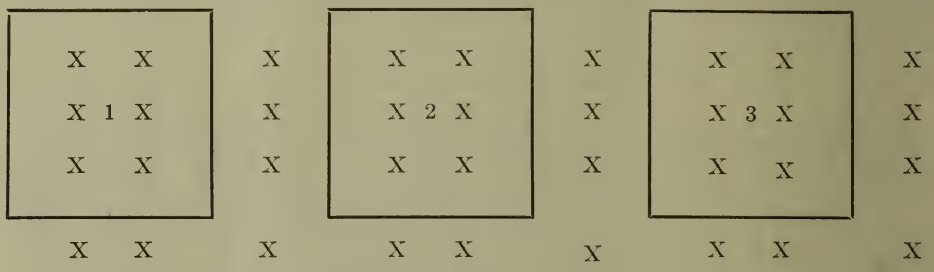
Nitrogen at present is available in numerous forms, many of which appear to be of equal value for orchard use. It is not within the scope of this work to evaluate these different fertilizers, but it may be added that the following have been used and appear to give satisfactory response: Nitrate of soda, both the Chilean and the artificial, calcium nitrate, sulphate of ammonia and Urea. The above are relatively quickly available, particularly the nitrates, and it is in these forms that nitrogen should generally be applied.

The three most common forms of phosphorus are acid phosphate, basic slag and bone meal. For sod orchards, acid phosphate, the most readily available form, should be used, but for orchards in cultivation probably basic slag meets the requirements as well as any form and possesses the added advantage of containing some lime, which will help to maintain proper conditions in the soil with regard to acidity.

Of the forms of potassium, probably muriate of potash is the one to be most recommended for orchard use.

A SIMPLE FERTILIZER EXPERIMENT

Until such time as there is much more information available concerning the value of different fertilizers on different types of soils and under different conditions, commercial orchardists should attempt a simple set of fertilizer experiments under their own conditions. A plan of such a scheme is offered here for suggestion:—



In the above scheme six trees are included in each plot and there is a row of trees between each plot from which no record would be taken; they act as buffer rows. Three plots are considered in all and could be treated as follows:

No. 1, nitrogen only, applied in form of nitrate of soda early in spring.

No. 2, nitrate of soda applied early in spring, plus acid phosphate or basic slag.

No. 3, nitrate of soda applied early in spring, plus acid phosphate or basic slag and muriate of potash.

Interpretation of Results

These applications should be continued over a long period and no results expected until the year following the first application. If none of the plots shows an increase in yield or results over the balance of the orchard, the use of fertilizers for the time being is not a vital factor in that particular orchard.

If plot No. 1 showed an increase it would be reasonable to assume that nitrates were of value. If plot No. 2 showed an increase over No. 1 it would indicate that under those conditions phosphates were required, and so on.

The cost of such a test would be negligible and the labour involved would be very slight, while the ultimate value in the economic application of fertilizers might mean many dollars in the grower's pocket.

SYSTEMS OF CULTIVATION

Different systems of cultivation are frequently practised and each may have its application to certain conditions. The more common of these are described below:

Clean cultivation with cover crop.—This is the most generally advocated of all systems and is considered the wisest and most economic of all from the standpoint of maintenance of moisture and fertility. It consists of maintaining a dust mulch in the orchard from early spring until some time early in July.

"Dehorned" Northern Spy in orchard of Jos. Tweddle. Ten to twelve feet was removed from the top.

By commencing operations as early as possible in spring, soil activity at the critical period is augmented and by the maintenance of the dust mulch throughout the major part of the growing season, soil moisture is conserved to the best advantage. The use of a cover crop in conjunction makes possible the maintenance of the humus content of the soil and on very poor soils where it is necessary to supply large quantities of nitrates the use of leguminous cover crops presents a moderately cheap means of supplying a large portion of the required nitrogen. By seeding down the orchard in early July there will not be competition between tree and cover crop for moisture until late summer, at which period the tree ordinarily has more than a sufficient supply. This system, or a modification of it, is the one recommended generally wherever it is possible to practise it.

Clean cultivation.—This resembles the first mentioned system, but differs in the respect that no cover crop is sown and that generally the dust mulch is maintained throughout the entire summer. Such a system does not permit of the utilization of green manures to maintain humus content and is thus very wasteful of soil fertility, generally necessitating the use of fairly large amounts of barnyard manure for that purpose. It is not to be recommended for general adoption.

The rotation of cultivation system.—This has given excellent results in some localities and, where it is possible to practice it is probably as desirable as clean cultivation and cover crops. In orchards where the green apple bug or similar insects are prevalent, it may not be possible to adopt such a method, but where this pest has been kept under control by spraying it is well worth a trial. The system is to sow every other ridge to some good cover crop in the spring, and allow this crop to occupy the land for one full year. This leaves every other ridge to be kept cultivated until July 1, when it was sown to cover crop. The following fall or next spring the ridge which had been in cover crop all summer is ploughed and kept cultivated until July, while the other ridge is allowed to grow a cover crop for the whole season. This keeps on alternating year by year. There are two great advantages in this system: (1) lessened cost of labour, and (2) the increased supply of humus obtained by allowing the cover crop to hold the land for a whole year. Up to July first the ridge which is growing crop is cut every few weeks and the crop allowed to remain on the ground as a mulch.

The Grass Mulch System.—This system of orchard management appears adapted to most of the orchard sections of eastern Canada. It offers a somewhat cheaper method of maintenance than the clean cultivation and cover crop system and is particularly superior on stony or rough land. It also provides a good system for the development of fruit colour and when sufficient mulch is provided this method appears quite equal, if not superior, to the dust mulch or clean cultivation for moisture control.

It is lacking in one essential, namely, nitrate nitrogen when compared with the clean cultivation system. This latter system offers an opportunity for the warming up and the aeration of the soil in early spring, with a resultant rapid increase in the nitrate nitrogen content of the soil. This particular form of nitrogen is especially valuable for fruit trees so that to overcome this deficiency on the part of the grass mulch it is imperative that quickly available forms of nitrogen be supplied, such as nitrate of soda or sulphate of ammonia.

The grass mulch system must not be confused with the sod orchard where no attempt is made to control moisture by maintaining a proper mulch. Orchards now in sod can be quickly changed over to the mulch system by the simple addition of old hay, straw, or similar material, at the rate of about 100 pounds per tree, spread out as far as the drip of the branches. It will probably be necessary to repeat this mulch application for two or three years, after which the grass cuttings from between the rows should be sufficient to maintain a satisfactory mulch, with possibly occasional additions of foreign material. The space between the rows of trees beyond the drip of the branches may be left in sod and cut two or three times during the growing season, the cuttings being raked up and thrown under the trees. In this way mulch maintenance is considerably cheapened without any apparent loss in efficiency. The importance of maintaining a proper mulch has been amply demonstrated at our Abbotsford orchard, where there has been a distinct difference in favour of the mulched area as compared with the sod. The trees in the mulch area have been swung from biennial to annual bearing, while the trees under sod are still producing crops only every other year. Foliage, colour and size of fruit is far superior on the mulch area to that on the non-mulch area.

As an example of the possibilities of the grass mulch system on a closely planted area of Wealthy the following analysis of a closely planted Wealthy orchard is presented.

This orchard was originally set in 1896. The trees were 10 x 10 feet and the entire block contained 144 trees. During the course of years many trees have died or have been removed to make room, until now only about half the original number remains, namely, sixty trees.

RESULTS FROM A CLOSELY PLANTED WEALTHY ORCHARD

From time to time, in the annual reports of this division, details have been given of the financial results from a closely planted orchard of the Wealthy apple, set out in 1896. The trees were originally set at 10 by 10 feet and the entire block consisted of some one hundred and forty-four trees. During the course of years many trees have died or have been removed to make room, until now only about half the original number remain, viz., sixty-two.

The orchard has been grown on the sod mulch system and is a pretty good example of the possibilities of that system of orchard practice. The grass, while permitted to grow over the entire area, is kept cut and permitted to lie as a mulch. Thus, while the method adopted is not considered as good practice as where foreign mulch material may be used to assist in maintaining an adequate mulch beneath the trees, nevertheless, as far as moisture content has been concerned, it has given quite satisfactory results. Obviously such a system of orchard management is liable to leave the trees somewhat deficient in nitrate nitrogen, as very little of this form of nitrogen is to be found under sod. This has been overcome by the use, in the early years, of considerable quantities of manure, but for the last five years chemical fertilizers have been relied upon to provide the deficiencies of plant food. At present each tree receives an application of three and one-half pounds nitrate of soda, one pound acid phosphate and half a pound of muriate of potash, applied in early spring.

While the growing of the trees so close in the early years has resulted in a rather "leggy" looking orchard, the cropping ability of the area has been very satisfactory and the net profits per acre, over a long range of years, has been a practical demonstration of the profit potentialities of an orchard in this district and particularly of one under this system of management.

DETAILED RETURNS FROM CLOSELY PLANTED WEALTHY ORCHARD FOR 1927

Expenses, 1927		Estimates per acre
Mowing, 1 man, 6 hours at 34 cents	$ 2 04	
Spraying four times	4 80	
Material for spraying	13 00	
Picking fruit, 67 hours at 34 cents	22 78	
Packing fruit, 54 hours at 34 cents	18 36	
Rent of land	3 96	
518 baskets at 7½ cents	38 85	
Fertilizer and its application	10 00	
Total	$ 113 79	$ 394 35
Receipts		
518 baskets of apples at 50 cents	$ 259 00	$ 829 31
Net profit	145 21	464 96

NOTE.—No charge for pruning in 1927, as orchard was not pruned that year.

RETURNS FROM CLOSELY PLANTED WEALTHY ORCHARD SINCE DATE OF PLANTING

Net profit per acre 1896–1920	$ 3,522 06
" " 1921	411 10
" " 1922	131 28
" " 1923	475 30
" " 1924	102 78
" " 1925	377 83
" " 1926	7 53
" " 1927	464 96
Average yearly net profit per acre	171 64

AVERAGE COSTS PER ACRE

As a very strict account has been kept of all work performed on the above area the figures are rather illuminating as to the cost of maintaining a sod mulch orchard in first-class condition. As the costs in the early days were based on lower wages than now prevail they have little value for present-day conditions,

but the last five years give an excellent idea of the working capital required for a full bearing orchard. This five-year average works out to $297.87 per acre per year. This includes cost of harvesting and packing and cost of packages.

AVERAGE YIELDS PER ACRE

The accumulated data also provide an opportunity to estimate the probable yields per acre of Wealthy apples in five-year periods from the date of first yields, which was three years after planting. The accompanying table gives the yield for each year, the five-year totals and averages and the approximate average yearly yield per acre in barrels.

A closer analysis of this table is extremely interesting. In the first place the orchard reached full bearing in 1902, six years after planting. In that year it produced almost as large a yield as at any time in its history, 2,351 gallons, or about 300 barrels per acre. This is an excellent yield and is all the more impressive if considered in terms of barrels per tree from an orchard planted at regulation distances. At 40 by 40 feet, when planted on the Quincunx plan, and filled one way, we get forty-three trees to the acre. On this basis the three hundred barrel yield is well over six barrels per tree, which would be considered an excellent yield in most fruit districts.

The next point worthy of note is that even in the first five-year period the average annual yield was close to one hundred barrels per acre, while in the second five-year period the maximum yearly average of one hundred and seventy-five barrels was reached.

This maximum yield per acre being reached six years after planting is entirely due to the closeness of the trees. While the yield per tree is low, it is the acreage yield which counts. Trees set standard distances apart would not begin to approach these acreage yields until the fifteenth or sixteenth year, by which time this orchard had been showing maximum acreage yields for ten years.

There was very little variation in average yearly yield during the second, third and fourth five-year periods, in fact the averages for the second and third periods are exactly the same. After the fourth five-year period the yields began to drop and are now approximately one hundred and fifty barrels per year, which is almost exactly the average for the entire twenty-nine years.

Briefly then we note that maximum production per acre was reached in six years after planting, and that the period of maximum production extended from the sixth year to the twenty-first year (1916) before any reduction in crop could be observed, thus giving at least fifteen years of maximum production, which has been followed by eleven years of average production.

YIELD OF WEALTHY ORCHARD FROM TIME OF PLANTING TO 1927

Year	Number of trees growing	Yield in gallons	—
1899	139	255	
1900	139	598	Total yield for five years.... 3,907 gal.
1901	139	380	Average yield per acre..... 781 "
1902	139	2,351	Average yearly acreage yield. 99 bbl.
1903	132	323	
1904	132	2,134	
1905	131	1,247	Total yield for five years..... 6,829 gal.
1906	131	886	Average yield per year..... 1,365 "
1907	122	593	Average yearly acreage yield. 175 bbl.
1908	122	1,969	

Year	Number of trees growing	Yield in gallons	——
1909	108	2,210	
1910	105	939	Total yield for five years..... 6,825 gal.
1911	105	458	Average yield per year..... 1,365 "
1912	103	2,678	Average yearly acreage yield. 175 bbl.
1913	92	540	
1914	92	1,893	
1915	92	690	Total yield for five years..... 6,912 gal.
1916	90	2,240	Average yield per year..... 1,382 "
1917	90	385	Average yearly acreage yield. 175 bbl.
1918	87	1,704	
1919	77	1,258	
1920	74	1,095	Total yield for five years..... 5,871 gal.
1921	73	1,571	Average yield per year..... 1,174 "
1922	72	699	Average yearly acreage yield. 151 bbl.
1923	70	1,248	
1924	68	476	
1925	67	2,193	Total yield for four years..... 4,873 gal.
1926	62	454	Average yield per year..... 1,215 "
1927	62	1,750	Average yearly acreage yield. ,154 bbl.

The Sod Strip Method.—Another method is to cultivate strips between the rows, leaving a narrow strip of sod next to the trees. This works well if the sod next the trees is not cropped. If it is kept cut and the cuttings allowed to remain as a mulch this system is commendable and is especially suited to orchards where it is difficult to get very close to the trees.

A modification of the above is to cultivate next the trees, leaving the sod in the centre. In young orchards this is probably a good practice as the roots will not have spread to the centres of the rows, but in the old orchard it is not to be recommended.

Intercropping the Orchard.—The question often arises as to the practicability of utilizing the vacant land between the rows of trees. In young orchards, not too closely planted, where the trees are not utilizing all the available space, such practice may be adopted successfully. A strip of land as wide as the spread of the branches should be left close to the trees, and it is advisable that this be treated under the cover crop system. Hoed crops, such as potatoes, strawberries, etc., are to be preferred to crops of grain or grass as occupants of the land between the rows. Mistakes are often made when intercropping by attempting to utilize the land too close up to the trees. This is especially undesirable when an intercrop which requires a large amount of manure or nitrogenous fertilizer is being used, for in such instances the supply of nitrogen to the trees is greatly increased and late growth may be stimulated, with the result that injury due to winter killing is very liable to occur. Provided, however, that a reasonably wide strip is left on both sides of the trees, danger from this source is not very great. Instances have been recorded where tall growing intercrops, such as corn, when planted too close to the trees, have prevented the bark from properly ripening or hardening, with the result that a large number of trees were killed by sun-scald the following winter. Such tall intercrops, which shade the trunks too much in autumn, should not be grown very close to the trees.

COVER CROPS

The following treatise on this subject is taken from Experimental Farms Bulletin No. 86, "The Apple in Canada," by W. T. Macoun, Dominion Horticulturist:—

"The importance of cover crops as a factor in the successful culture of large fruits is now well recognized, although it is only during recent years that

much attention has been given to the subject. The main uses of the cover crop in the orchard are: to hold the snow in winter, and thus afford greater protection to the roots of the trees; to prevent the thawing and freezing of the ground; to lessen the depth to which the frost will go in the soil; to furnish vegetable matter in the spring for the purpose of obtaining humus and nitrogen; and to act as a catch-crop in autumn to prevent the leaching of plant food made available during the summer. The cover crop is also a means of reducing the moisture in the soil by transpiration, and thus aids in ripening the wood of fruit trees liable to be injured. In certain parts of Canada, some of the uses of the cover crop are more important than in others and some plants are better adapted for special purposes, hence the plant which makes the best cover crop in one

"Dehorned" Tompkins King trees in orchard of W. H. Bunting, St. Catharines, Ont.

district may not do so in another. Where the soil has been long cultivated, as in the older settled parts of Ontario, and needs additional plant food, especially nitrogen, a leguminous plant, or one which will take free nitrogen from the air and thus add a large quantity of this useful and expensive fertilizer to the soil at slight expense, is usually best; while where the soil has not been long under cultivation and is well supplied with humus and nitrogen, a non-leguminous plant may be better, as the holding of snow and the protection of the roots of the trees is more important than adding fertility to the soil, especially where the snowfall is light.

"In the colder parts of Canada, where there is usually plenty of moisture in summer, it is better to sow seed for the cover crop in the first half of July, rather than in the second half, as it is important to have the wood of trees thoroughly ripened before winter sets in, and by sowing the seed early the growth of the tree should be aided in ripening by the drying of the soil caused by the transpiration of moisture from the growing cover crop. In the dryer and milder parts of Canada it is not necessary to sow seed for the cover crop until about the middle of July, as the early ripening of the wood is not so important as the conserving of moisture in the soil by cultivation through the early part of

the summer. After the seed is sown the soil should be rolled with a heavy land roller, which will cause the moisture to rise to the surface of the soil and assist the germination of the seed. This rolling is very important, as should the seed lie in the ground for any length of time without germinating there will not be time for a good cover crop to be formed before winter. No nurse crop is, as a rule, necessary. Some of the desirable characteristics of a good plant for cover crops are, first that it will germinate quickly and grow rapidly, so that weeds will be checked. It should be a strong grower, as there should be a dense cover to prevent the frost from penetrating deeply into the ground. It should stand fairly erect, so that it will hold the snow well in winter. It should also be a plant which can be easily handled in the orchard. In districts where there is danger of making the soil too dry by late growth a cover crop should be chosen which will be killed by early frosts. Among the plants which have been tested as cover crops at Ottawa, are: Crimson Clover, Mammoth Red Clover, Common Red Clover, Alfalfa, Soy Beans, Cow Peas, English Horse Beans, Hairy Vetch, Summer Vetch, Buckwheat and Rape.

"*Soy beans* sown in drills 28 inches apart, at the rate of 37½ pounds per acre, on June 18, made a good growth, but were killed by the first frost, and are hence not satisfactory. Cow peas are too tender.

"*English Horse beans,* sown in drills 28 inches apart, at the rate of one bushel per acre, have done well and continue growing till severe frosts. They hold the snow well in winter as they do not break down easily. They are rolled in the spring and work into the ground easily. Rape, sown broadcast among the Horse beans, makes a good bottom cover.

"*Hairy Vetch* is a good cover crop, making strong growth late in the season. It may be sown broadcast or in drills. It is somewhat difficult to plough under in the spring.

"*Summer Vetch or Tares.*—The Summer Vetch is much cheaper than the Hairy Vetch and is a rapid grower. It should be sown at the rate of about 50 pounds per acre. It kills out in the winter, but furnishes a good cover.

"*Buckwheat.*—This is not a good cover crop, as it adds no plant food to the soil, and the leaves are killed by the first frost, but it is better than nothing and sometimes proves useful for late feed for bees, at the same time helping to hold the snow.

"*Rape* grows rapidly in the autumn and makes a good ground cover. It does not add any plant food to the soil, but is easy to plough under in the spring, as in most places it is killed by winter. Of the non-leguminous plants, or those which do not add nitrogen to the soil, it is one of the best; on the prairies, particularly, this has been found very satisfactory, as with it one is practically sure of a good crop and one that will hold snow well. At Ottawa, rape and tares in the proportion of 6 pounds of the former and 30 pounds of the latter have been sown for a mixed cover crop, the latter furnishing the nitrogen. From 8 to 10 pounds of rape seed alone per acre ensures a good stand.

"*Crimson Clover* has been found too uncertain in the colder districts, the plant not making sufficient growth before winter. In some districts it does well sown at the rate of 10 pounds per acre. Mammoth Red Clover and Common Red Clover, sown about the middle of July and earlier, at the rate of about 12 pounds to the acre, make very good cover crops, the Mammoth Red giving a little the better results.

"*Alfalfa* is not as satisfactory as Mammoth Red Clover, being more exhaustive of soil moisture and more difficult to handle in spring. It has been grown considerably in the irrigated districts of British Columbia recently both

as a cover crop and for hay, but the temptation is to irrigate for it to the detriment of the apple trees, hence it is doubtful if it is wise to grow it in orchards there unless irrigation is very carefully done."

Mr. R. H. Helmer, Superintendent of the Dominion Experimental Farm at Summerland, B.C., says in this connection:

"We cannot advise alfalfa indiscriminately as water and depth of soil play a big part in its use, but we can advise that when grown it be used as a mulching crop and not as a hay crop. Do not cut it at all, allow it to rot from year to year on the land, only ploughing irrigation furrows through it each spring. This is by far the cheapest method of orchard practice, but until alfalfa has been proven successful under various conditions, we would recommend the use of Hairy Vetch."

In this connection it might be mentioned that at the Summerland Experimental Station a system of permanent hairy vetch has been used with excellent results. After sowing the vetch in spring for the first time, it is permitted to grow and ripen seed. As soon as a good quality of seed pods is ripe, the crop is flattened with a stone boat and disced until it is gradually worked into the soil and a friable surface produced. The seeds which were turned under with the vetch are then permitted to sprout and will soon give a heavy crop of vetch for winter protection, which will start growing in spring and again produce seeds, when the same treatment is given. This system, of course, is only possible on irrigated lands.

Sweet Clover.—Although sweet clover has been in prominence now for some few years as a possible forage crop, its possibilities for orchard use have not been very fully investigated. The whole question is still in the experimental stage, although some Experimental Stations are very favourably impressed with it. Sears of Amherst reports that they think well of its possibilities. He says in part:—

"It is usually necessary to lime the block, if one is to get the best results, and often the first time that you seed down a block you do not get a satisfactory growth, but as soon as you get it once established it will reseed itself if your cultivation is not too thorough, and it has had in our case a very remarkable effect on the growth of the trees. The block where we have tried it out is in our variety orchard so that the trees in the block are several different varieties, but without any exception these trees, growing in the sweet clover block, are very markedly more thrifty, and the leaves a much darker green than on the adjoining blocks with other cover crops."

The objections advanced against its use are (1) the possibility of its becoming troublesome as a weed, (2) that it makes a very inferior growth the first year on poor soils, (3) that, being a biennial, it is liable to make little growth between July 1st and autumn, and that there is a temptation to let it grow in spring and use it for hay. As no data are at hand regarding rate of seeding the same rate as for other clovers, namely, about twelve to fifteen pounds per acre, is suggested.

SPRAYING

On the proper carrying out of this operation will depend largely the success of the grower. No matter how healthy and vigorous the orchard, unless it is properly sprayed disaster is sure to come sooner or later. It cannot be urged upon the fruit grower too strongly to give proper attention to this operation in the minutest detail. Recent investigations in the control of orchard pests and fungous diseases have proved conclusively that all these can be controlled profitably. On the other hand they have proved equally as conclusively that a little bit of neglect, ignorance or carelessness will cause the undoing of all the

good work done by other operations. Not only is it possible by neglect of spraying to ruin the current crop, but it may also either reduce or entirely eliminate the possibility of a crop the following year. Fungous diseases and insect pests cause a large reduction in the leaf area of the tree thus preventing the proper accumulation of food materials for the formation of fruit buds. Bearing in mind the discussion on page 12 it can readily be seen how imperative it is, therefore, to maintain a healthy, vigorous foliage on an apple tree. As it is impossible to perform a good job of spraying without proper tools the following section is introduced before further discussion takes place:

APPARATUS

The apparatus to be used in spraying will depend to a certain extent on the size of the orchard, but in any case a highly efficient outfit is required.

For the large commercial grower the power outfit is necessary, but for the man who has only a small area, say one or two acres, a good hand pump will do. There are many good hand pumps on the market so that one need not purchase a poor one. The hand pump will generally run only one line of hose to good advantage. If a two-man pump is used, two lines can be run. Be sure to get a pump which will keep up a good pressure, as this is the essential point.

For an orchard of five acres or more a power outfit should be used, as with these machines a much higher pressure can be maintained than by the old hand pump. To do a really good job of spraying, a high pressure of 200 to 250 pounds is essential. With this pressure the spray can be driven into the centre of the trees and a much more thorough job done than with the old hand pump, the pressure of which it is hard to keep above 45 to 50 pounds.

POINTS TO CONSIDER IN PURCHASING A POWER SPRAYER

1. *Power and Efficiency.*—A two and a half horse-power engine is at least required. An engine of lower horse-power is not entirely satisfactory. The pump should have at least a capacity of seven to nine gallons per minute when the pump is pumping without maintaining pressure but working normally, and a capacity as high as twenty gallons per minute is better for large orchards.

2. *Compactness in Assembly.*—Some outfits are so geared that the distance between pump and engine is very great, requiring a large number of connecting cogs and wheels, with the result that on rough ground there is considerable apparatus to get out of order. The less gearing in this respect the better.

3. *Pressure.*—The pump and engine should be able to maintain 250 pounds pressure with four regular nozzles or two guns running.

4. *Size of Tank.*—The tank may vary in size from 150 to 250 gallons; in large, level orchards 250 gallons is to be recommended.

5. *Agitation.*—Some mechanical means of agitation, driven by the engine should be attached. Do not depend on the return hose system. It is not reliable. To get good results in spraying, constant agitation is necessary.

6. *Mounting.*—The whole is better mounted on an iron truck with four and one-half inch tires and high wheels to make the draught easier.

7. *Hose.*—Three-eights-inch hose is giving the best satisfaction. There is less friction in this size of hose than in the one-quarter-inch and it is lighter to carry than the one-half inch. In fact, it combines the lowest possible degree of friction compatible with lightness of hose.

8. *Nozzles.*—In selecting nozzles, select a nozzle which gives a fine, broad spray delivered with a good force. In most instances the angle nozzle is preferable to the straight nozzle, for with the angle nozzle the operator can both

spray up under the tree and down on to the tree by merely the turning of his rod. The use of the "Y", which will carry two nozzles, is to be recommended. This gives two regular nozzles to each line of hose, enabling the operator to cover his ground much more rapidly. The use of more than two nozzles to a line, however, is not advisable, as spray from each nozzle interferes with the spray from the other, so that when three are used there is liable to be almost a stream in the centre of the zone.

THINNING

Thinning fruit is a practice which has not become very widespread throughout Eastern Canada as yet. If the growers, however, were really alive to their opportunities much more thinning would be carried on in the future.

In thinning, those apples which are spotted or deformed are removed, and in cases where there are too many apples in a cluster, the poorer ones are removed, thus giving the remaining fruit a better chance to reach maturity and go into the No. 1 barrel.

The distance apart to leave the fruit is a matter of considerable controversy. A good, safe plan, however, is to thin so that no two apples will be touching each other or will be on the same cluster. Thinning experiments were carried on by the Experimental Station at Kentville, N.S., on their demonstration orchards, and excellent results were obtained. The apples thinned were the Blenheim Pippin. The apples were removed from the trees about the middle of July. The apples were all counted and records kept of the same. The fruit was thinned to one apple to the cluster; besides this, all spotted and ill-shaped apples were removed.

In the fall when the fruit was picked, the apples were counted as they were removed from the trees and the results were as follows:—

Number of trees unthinned	7
Number of barrels picked	37
Number of apples picked in the fall	24,014
Average number apples per barrel	649
Number of trees thinned	5
Number of apples removed in summer	2,099
Number of apples picked in fall	10,426
Total number on tree	12,525
Number of barrels tree run in fall	19
Average number of apples per barrel	549

Now had these trees not been thinned, the size of the apple would have remained the same as the size of the fruit on the unthinned trees, or 649 apples per barrel. This would have given a total yield in the fall of 19 barrels, which is exactly what was received, even after thinning, so that it is evident there was no decrease in bulk due to the thinning. The increased size of the apples remaining on the trees made up for the apples removed. When these apples were packed, the results of the pack out were in favour of the thinned plot and were as follows:—

	Thinned	Unthinned
Per cent No. 1	58·0	32·3
" No. 2	21·0	23·0
" No. 3	14·6	25·7
" Culls	None	12·5
" Slack	6·4	6·5

It will be noticed that the percentage of No. 1 apples is much greater from the thinned trees.

These apples were shipped to the English market, each lot being separate. The unthinned fruit was branded with ABF as a shipping mark, while the thinned fruit was branded MBD. They were sold on their merits only, the consignee not knowing there was any difference in the lots except from what he could observe in regard to quality.

The sales returns were:—

	Unthinned	Thinned
No. 1 per barrel	$ 1 67	$ 2 01
No. 2 "	1 67	1 66
No. 3 "	74	74

It will be noticed that the No. 1 apples from the thinned trees brought 34 cents per barrel more than the apples from the unthinned trees. With these figures the following results appear interesting when using 100 barrels tree run in each case as a basis to work on.

	No. of barrels	Unthinned Value	Total
No. 1	32·3	$ 1 67	$ 53 94
No. 2	23·0	1 67	38 41
No. 3	25·7	74	19 01
Culls	12·5	30	3 75
Slack	6·5	.....	.....
Total proceeds			$ 115 11

	No. of barrels	Thinned Value	Total
No. 1	58·0	$ 2 01	$ 116 58
No. 2	21·0	1 66	34 86
No. 3	14·6	74	10 80
Slack	6·4	.....	.....
Total proceeds			$ 162 24
Loss on 100 barrels due to not thinning			$ 47 13
Cost of thinning (actual cost)			5 00
Net loss due to not thinning			$ 42 13

The only conclusion that can be drawn from the above is that where the trees are at all loaded it pays to thin. In the case of such apples as the Baldwin, which produce heavily every other year, moderately large crops can be obtained every year if thinning is practised to some extent.

THE RENOVATION OF THE NEGLECTED ORCHARD

Throughout the different provinces of Canada are to be found orchards, old and young which have for some years been sadly neglected and abandoned. In many instances these neglected orchards are still capable of producing very profitable crops if the proper steps are taken to bring them back to condition.

In old orchards, which have been neglected, there will probably be very little new wood so that the first thing in mind will be to make the tree produce as much new wood as possible. As pruning in the spring of the year, say early in March, is conducive to wood growth, this is considered the best time to start that operation in the old, neglected orchard.

The first thing to do is to remove all dead and broken branches and all parts which are infested with canker or other diseases. Too much stress cannot be laid on the necessity of removing all canker-infested limbs, and in removing them cut well back into the good new wood. Afterwards, all this brush should be immediately burned, for if it is not destroyed it only forms a source of infection for the remaining healthy limbs.

Having removed all dead and diseased wood, it now remains to attempt to shape the tree into some desirable form. Many of these old trees only bear leaves and fruit spurs on the outside tips of the limbs, the remainder being destitute of both foliage and fruit. If this condition were to remain, the actual bearing surface of the tree would be so small that profitable crops would be an

impossibility. In order, then, to induce new shoots to grow from the lower parts of the branches a vigorous method of heading in or of "dehorning" must be adopted.

In cases where the trees are thirty feet or over, the top should be cut back all round, so that afterwards the tree will be about eighteen feet in height. This "dehorning" will induce a more spreading form of tree. In cutting, cut back to a healthy sprout or spur, and if the tree is too tall and not spreading enough, see that the spur that is cut back to is pointed outwards. On the other hand, if one is dealing with a tree which is too spreading, cut the lateral limbs back to a spur which is pointing upwards. In this way the shapes of the various trees may be modified to a large extent.

"DEHORNING"

The great possibilities of transforming these old barren trees into profitable bearers have not impressed themselves on a very large number of growers. Some excellent examples, however, are to be found in the Niagara district, and a few photos of some of these examples are contained in these pages.

Partially "dehorned" Baldwin trees in the orchard of Jos. Tweddle, Stoney Creek, Ont. Next year these trees can safely have the remaining five or six feet removed from the top, which will bring them down to the required height. Only about six feet was removed at the first "dehorning".

Removing such large quantities of wood as eight to ten feet would, of course, tend to make the tree throw out new sucker growths from all parts, although most of the growth will come from near the cuts. These suckers, by proper selection, can be used to form a new framework to the tree, thus giving practically a new tree. Suckers will not only spring from near the cuts, but will also arise from the lower parts of the tree, thus giving an opportunity to select the

strongest to form branches. By selecting the most favourably located of these suckers and by cutting them back, say, one-third, they will be induced to give forth laterals so that in a very few years a complete transformation can be made by use of these water sprouts.

It may so happen that the grower, if he were to remove about ten feet from the height of his tree in one year, would not have sufficient foliage bearing wood left to carry on the work of the tree. In this case, it would be advisable to remove only about five feet the first year, and in about two years' time, after the new sucker growth had become well enough established to carry on the work of the tree, the remaining five feet could be removed without any undue injury.

In distinct contrast to the poor, thin, old tree is the tree which is full of water sprouts and dense masses of wood. This latter tree is not so difficult to bring back into shape, for we have something more to work with. In this case a number of the water sprouts are removed entirely and the best selected to form the central framework of the tree. In these thick or bushy trees a large amount of brush must be removed in order to admit sunlight and air. In cases where very large amounts of wood must be removed, it might probably be better to remove only the dead and diseased wood the first year, then the second year

Showing excellent use of suckers or water sprouts. Note the large healthy water sprouts in the centre of No. 2. These will in a few years become large and branching enough to allow of the removal of some of the large top. Compare the large tree in the centre (No. 1) with its water sprouts, to the one on the left (No. 2) with its barren centre.

complete the operation. In the case of very tall trees which are to be dehorned, the same principle should be followed, that is remove about six feet per year until the branches are shortened to the desired length.

RESULTS OF DEHORNING

The results obtained from "dehorning" two orchards in the Niagara district are very interesting indeed. One of the two orchards was that of Mr. Jos. Tweddle at Stoney Creek. Here were found Baldwins, Greenings and Spys all

dehorned. They had been dehorned for two years and showed no signs of rotting at the cuts, except in one or two cases where the cuts were carelessly made by the pruner. In some cases Mr. Tweddle had painted the wounds and in other cases he had not. Although no rot was apparent in the unpainted cuts yet it seemed advisable to paint all wounds to keep out the weather and any possible infection from fungous diseases.

In the case of the Spys, some eight to ten feet had been removed and the results obtained were very satisfactory. Mr. Tweddle plans to dehorn during the year when he expects a full crop, so that the trees will not be inclined to put out too much sucker growth. In the Spys, the sucker growth is not overabundant, but yet sufficient to give a large amount of new wood to select a new frame from.

Probably the most interesting was his Baldwin orchard. Here were trees which, two years previous to treatment, had very little brush on them, and what

"Dehorned" Baldwin trees in the orchard of Mr. W. H. Bunting at St. Catharines, Ont. Too much sucker growth. Large quantities of these should be removed. An excellent new frame can be made by selecting these suckers. The value of these water sprouts is very great. This extreme suckering is due to "dehorning" in a year when the Baldwins were not bearing heavily.

they did have was located on the tips of long branches, giving the tree the appearance of an old paint brush. In this orchard five to six feet only could be removed the first year, for if more had been taken there would not have been enough foliage to carry on the work of the tree. Two years after treatment a great change had taken place. The old trees were practically rejuvenated. The result of the dehorning was that the trees put out a very vigorous growth of suckers, both on the tips of the branches and also well down to the main trunk. By selecting the best of these Mr. Tweddle formed practically a new tree, and the next year was able to take five feet more off the top, bringing his trees down to the desired height. He will have changed old tall trees with foliage only on the tips into moderately high, spreading trees with bearing wood and foliage from the tips back to the main trunk.

In the case of the Baldwins, the amount of sucker growth is perhaps a trifle too much. This is due no doubt to the fact that, owing to weather conditions, the crop was very light the year he dehorned instead of being heavy as he expected. This of course, gave the trees a tendency to put out a large amount of sucker growth.

In another orchard, viz., that of Mr. W. H. Bunting, are to be found Kings, Baldwins and Greenings all dehorned with excellent results, although the Baldwins in some cases have thrown out very large amounts of sucker growth.

THINNING OUT OF TREES

In many cases old orchards will be found to be so closely planted that to prune them or head them back sufficiently to enable one to work among the trees, would mean that practically the tree would be demolished. In such cases it is more profitable to remove some of the trees, probably every other one. This gives an opportunity for the remaining trees to develop into profitable bearers, whereas if they were allowed to remain thick, although there would be a greater number of trees, they would not yield as much as the lesser number of trees.

Where trees are so thick, it is impossible to spray properly, and hence either no crop at all or at least a very inferior one is the result, so that to remove some of the trees, although it may seem a drastic measure, is really the most profitable scheme.

If the orchard is planted on the diagonal plan, the tree in the centre of the square can be removed. In fact this is the only proper course of thinning that can be followed out in such a plantation.

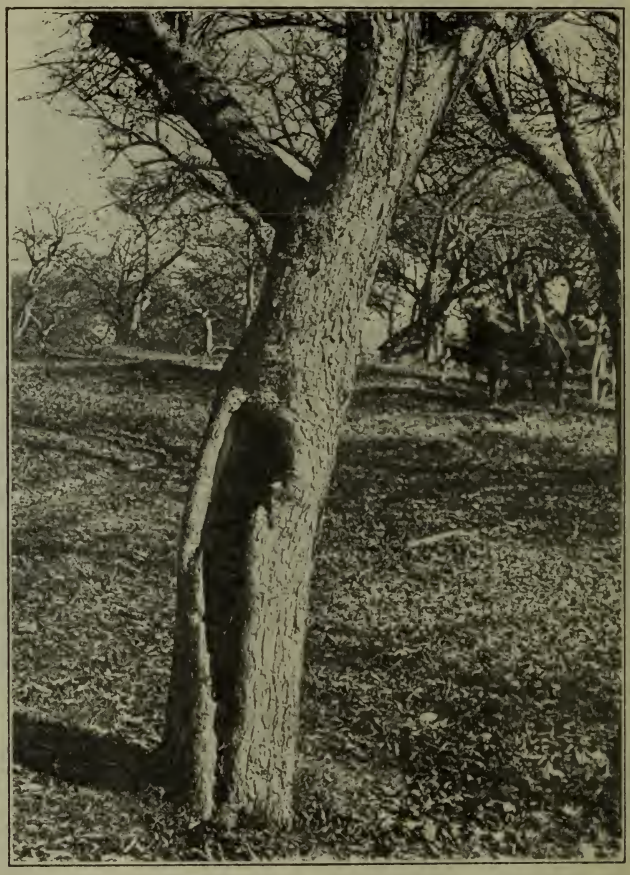
If planted on the square, however, every other tree can be removed, leaving the rows running diagonally across the orchard. In this case it would be best to make a plan of the orchard on paper, marking all missing trees and all undesirable trees. Then work out the plan of thinning which will take in the largest number of undersirable and missing trees; for instance, one may start by leaving the first tree in the first row, or start by taking out this tree. In each case one is removed, and instead of removing them entirely at once, head them back. Unless planned out on paper, one might remove a larger number of good, desirable trees than is necessary.

A good system to adopt is to make out this plan, select the trees to be removed, and instead of removing them entirely at once, head them back or thin them out vigorously, giving the trees which are to remain more room. This can be carried on year by year until the trees which are eventually to be removed will practically be demolished by the successive thinnings. This gives the grower some crop off these trees while the remaining trees are getting ready to fill in the spaces.

At this juncture it might be interesting to correlate this treatment with our knowledge of plant nutrition as described on page 13. In the neglected, nonbearing orchards, which are making little or no growth, the condition of excessive carbohydrates as compared to nitrates exists, so that by a reduction of the top the balance between these two is more or less re-established. The operations of ploughing and cultivating, will also tend to increase soil nitrification and thus further assist in the correction of the balance. Whether or not nitrates should be used in addition, during the first year, is a question the answer for which depends upon the amount of wood removed. If considerable top is removed and nitrates added in addition there is danger of maintaining too high a nitrate content late into the season with resultant late growth, unripened wood and severe winter injury. On the other hand, if only a small amount of top is removed, some nitrate may be safely applied. Caution and good judgment are required in the application of these treatments.

SCRAPING, CLEANING AND TREE SURGERY

In many instances there will be cases of split crotches to mend and dead parts to be removed, which will leave holes or areas for further trouble if not cared for. If a split crotch is in evidence, it may be bolted together and the crevice which is left should be filled in with grafting wax or cement to keep out all diseases such as canker. If there is a side of a large branch which has a hole in it, this should also be filled in with cement. Wherever the bark has been seriously broken and removed, this place should be cared for in somewhat the same way.



(Courtesy of Agricultural Experiment Station, Storrs, Conn.)

The result of leaving large wounds unprotected. Trees like this are scarcely worth renovating.

Sometimes it is noticed that a tree is dead on one side from collar rot, while the other half is in perfect condition. If there are suckers growing at the base, this tree can be saved by bridge grafting the suckers into the healthy portion of the tree. These suckers, being on good, healthy roots, will soon increase in size, and probably by the time the tree is completely girdled these new roots will be able to take care of the old top, and the tree will thus be saved. Many instances of saving trees in this manner may be cited.

If the trees are covered with old moss and scurfy bark, they should be scraped. A short-handled hoe, well sharpened, will do admirably for this work. They may be scraped in early spring. This scraping removes all loose bark and hence leaves fewer crevices for scale insects and other diseases to get a foothold in.

During the growing season of 1919 some experimental work in tree surgery was undertaken at the Central Farm. The winter of 1917-18 had done considerable damage to many of the trees in the orchard, which left them in a condition requiring immediate attention.

Showing large cavity cleaned out and nailed ready for filling.

Wherever possible, an attempt was made to save a tree and prevent any further decay, different mixtures and methods being used for filling the cavities after they had been cleaned out.

In all cases, cavities were cleaned out thoroughly by removing all decayed and decaying wood with chisels. After all this material had been cleaned out of the wound, it was then disinfected with corrosive sublimate, one part to five hundred of water, followed by an application of creosote. Care was taken to prevent either the sublimate or the creosote from coming into contact with the living tissue surrounding the wound.

After the disinfection of the cavity, nails were driven in for the purpose of holding the filling.

Two methods of filling wounds were adopted. The first was what is called the brick method and is illustrated above.

This method consists of placing the mixture in the wound in layers, and between each layer is placed a sheet of roofing paper. For large cavities, such as illustrated, this is recommended, as it allows for a certain amount of movement when the tree is racked by the wind and tends to prevent cracking of the mixture.

The second method was simply to fill the cavity with the mixture in one solid block.

Showing cavity being filled by brick method.

For filling the cavities, cement mixed in the proportions as set forth in the following table was used:—

MIXTURES FOR TREE FILLING

Mixture Used	Remarks based on notes taken in early part of 1921
Cement, 2 to 1 mixture, no waterproofing	Considerable cracking, mixture too rich in cement.
3 to 1 cement, no waterproofing	Perfect condition, no cracking.
4 to 1 cement, no waterproofing	Perfect condition, no cracking.
2 to 1 cement and plaster mixture	Composition crumbling, of no value.
3 to 1 cement and plaster mixture	Badly cracked, crumbling.
3 to 1 cement and waterproofing, 1 pt. to 5 gal	All in first-class shape except one large one done by solid mass method, which should have been bricked.
2 to 1 cement, waterproofed by painting after set	Some cracked, some in good condition.

Recommendations

From the results of this experiment to date certain recommendations may be made.

The cavities should all be thoroughly cleaned out and all decayed or decaying wood removed. A strong disinfectant, such as corrosive sublimate, 1 to 500, or creosote, or both, should then be applied to the cavity, taking care that neither of these solutions comes into contact with the living bark surrounding the cavity.

After disinfection, the cavity should be filled with nails as illustrated, the size of the nails to be used depending upon the size of the cavity, generally a $2\frac{1}{2}$ inch nail is best suited. The bark surrounding the cavity should then be cut back to living tissue in order to give the wound an opportunity of healing over.

The cavity is then ready for filling. From our experience, a 3 to 1 mixture of cement and very fine gravel is the best; that is, three parts of very fine gravel to one of cement mixed with sufficient water to form a grout of such consistency as will just fall off the end of a trowel without running. If the cavity is a long vertical one, the brick method of filling should be used. If just a small or local crotch cavity, the solid mass method will suffice.

After packing the cavity with the mixture, the outer surface should be smoothed and care taken that the filling does not protrude so far beyond the outer circumference of the wood of the tree as to prevent the bark from growing over it when the wound commences to heal. If no attention is paid to this, the growing bark will press against the mass and either split the tree or crack the cement. This is a common cause of poor results in tree surgery.

The final step is to wrap wet sacking around the filling for a few days until the mass is well set, after which the sacking may be removed without danger of the composition drying out too quickly, with resultant cracking.

Waterproofing.—Apparently it is not necessary either to mix waterproofing with the cement or to paint it over with a waterproofing after it has set. In fact, when waterproofing was mixed with the cement it appeared to lessen its resistance to freezing and thawing.

INSECTS ATTACKING APPLE TREES

By

William A. Ross, *Entomological Branch*

Apple trees are attacked by a host of insects which cause many types of injury. Insects destroy the buds, defoliate the trees, tunnel into the wood and feed on the bark, and by their depredations weaken the trees, decrease their fruitfulness and, in extreme cases, kill the trees outright. Certain species ruin the fruit by burrowing into it and some, by piercing the young fruit with their sharp sucking mouth parts, others by eating out holes in it, give rise to ugly deep or shallow scars, depressions or other malformations on the mature fruit, which makes it unmarketable or degrades it.

Fortunately, effective and economical methods of controlling all the major pests of apple trees have been devised, and with our present knowledge it is, generally speaking, possible for apple growers at a reasonable cost to prevent serious insect injury. In all the important fruit growing districts of Canada growers may now secure from the local agricultural authorities spray calendars in which are outlined spray schedules, based on local experience, and which, if followed faithfully, will keep insect damage down to small proportions. No commercial fruit grower should attempt to grow apples without the guidance of a spray calendar.

In the following paragraphs only some of the most important insect pests of apple are discussed.

Codling Moth (***Carpocapsa pomonella*** Linn).—The codling moth is unquestionably the most destructive and best-known pest of the apple in North America. It occurs in all parts of Canada and in Ontario, Quebec and sections of British Columbia is responsible annually for very heavy losses.

Fig. 1.—Codling moth caterpillar and its destructive work in apple (after Gibson and Twinn).

The larvae of the moth—whitish or pinkish caterpillars—eat their way into the fruit and feed inside on the pulp and seeds, and the infested apples either fall prematurely or are rendered unmarketable. The characteristic deep burrows, usually with brown castings protruding from them, made by the codling worm through the calyx end or side of the apples, are very familiar to all orchardists, but it is not generally known that the injuries commonly called "stings" or pin-holes are also the work of this insect.

In orchards where the codling moth is especially severe, the following treatment is necessary: (1) Immediately after the blossoms fall, spray with 1½ pounds arsenate of lead in 40 gallons of lime sulphur or any other fungicide recommended; (2) Four weeks later apply a cover spray of 2 pounds arsenate of lead in 40 gallons of water or, if required, a fungicide and, in cases where this does not give satisfactory results, repeat the application two weeks later. In applying the sprays, care should be taken to cover thoroughly the under and upper sides of the leaves and all parts of the fruit. Fortunately, in most of the fruit-growing areas of Eastern Canada the codling moth can be controlled satisfactorily by spraying once, immediately after the blossoms fall.

Apple Maggot (*Rhagoletis pomonella* Walsh).—The apple maggot or railroad worm occurs in most of the fruit-growing districts of Eastern Canada, and in many orchards has caused serious losses, amounting in some instances to the entire crop.

FIG. 2.—Malformed apple and tunneling in apple—work of the apple maggot (after Gibson and Twinn).

The female insect, a two-winged fly, inserts her eggs beneath the skin of the apple, and the maggots, hatching therefrom, tunnel their way here and there through the pulp, leaving behind them trails of dead brown tissue. This affected tissue or pulp is generally tough, hence the term "woody" which is commonly applied to maggot-infested apples. Badly attacked fruit, particularly early varieties, may become so honeycombed with maggot tunnels that it will break down into a rotting mass. Apples infested with the maggot show external signs of injury in the form of egg punctures—brownish, circular spots about the diameter of a pin—which are situated usually, though not always, in small depressions. When the fruit is cut open, internal signs of injury in the form of small areas and trails of dead tissue are very apparent.

The apple maggot may be controlled by spraying with 1½ pounds of arsenate of lead in 40 gallons of water, or if required a fungicide, four weeks after the blossoms fall and again two weeks later. Where the services of an entomologist or spray supervisor are available the first spray should be timed so that it will be applied as soon as the flies begin to emerge.

The Lesser Apple Worm (*Laspeyresia prunivora* Walsh).—The lesser apple worm, a close relative of the codling moth, is usually of very minor importance but occasionally it causes considerable losses in apple orchards. The worm—a reddish or flesh-coloured caterpillar—burrows into the apple, feeds on the pulp near the surface, and gives rise to blotch mines on any part of the fruit but most commonly at the calyx end.

The remedial measures recommended for the codling moth will control this insect.

Fruit-Tree Leaf-Roller (*Cacoecia argyrospila* Walker).—The fruit-tree leaf-roller ranks among the most destructive pests of the apple in British Columbia. It occurs, also, in most of the fruit-growing sections of Ontario, but is of importance in only a comparatively small number of orchards in widely separated districts.

The leaf-roller caterpillars—yellow green worms about 1 inch long when full grown—attack the opening buds and later on, the leaves and fruit. They roll and tie the leaves with silken threads and thus form shelters within which they conceal themselves. Their feeding activities result in ragged foliage, but much more serious injury is caused by the worms eating out irregular cavities in the young fruit. Such fruit either falls or, if it matures, is so badly malformed with sunken scars that it is unmarketable.

The only satisfactory method of combating this insect is to apply a spray of 8 per cent oil in early spring before the buds show green at the tips.

The Plum Curculio (*Conotrachelus nenuphar* Hbst.).—The plum curculio is especially notorious as a pest of plums, cherries and other stone fruits, but it also attacks and may seriously injure apples. Generally speaking, it is only of importance in apple orchards situated near woods, waste land or thickets, in orchards where apples are interplanted with stone fruits; and in neglected orchards where clean cultivation is not practised.

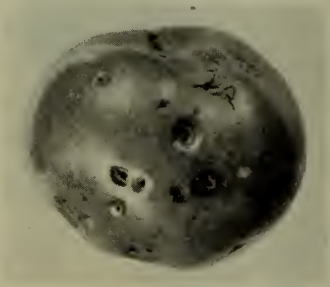


Fig. 3.—Feeding punctures on apple made in late summer by plum curculio (original).

The curculio—a rough-backed, greyish-black snout-beetle about ⅛-inch long—injuries the fruit in four ways, viz: (1) young fruit is deformed by the overwintering beetles eating out holes in it; (2) fruit is malformed by the female making, in the operation of egg-laying, small characteristic cresent-shaped wounds; (3) most of the fruit infested by the larvae or grubs falls prematurely; and (4) in late summer and fall the new brood beetles eat out holes in the apples. On nature apples, plum curculio injury is quite readily detected by the presence of distinctive, more or less crescent-shaped scars, and conspicuous feeding punctures, with the pulp eaten out under the skin surrounding the punctures.

Two measures are of importance in the control of this pest viz. (1) Orchard sanitation. The importance of this as a very effective means of preventing plum curculio injury is clearly shown by the fact that well cultivated orchards with clean surroundings, free from rubbish, thickets, shrubs, stone walls or

piles and other suitable hibernating quarters, are rarely if ever seriously injured by this insect. (2) Spraying. In most cases no further treatment is required other than the regular pre-blossom and post-blossom applications of an arsenical *e.g.* 1½ pounds arsenate of lead per 40 gallons of spray mixture. But, in orchards, where conditions are particularly favourable for the insect, the trees should be sprayed again with 1½ pounds of arsenate of lead in 40 gallons of water seven days after the calyx application and, if necessary, the treatment should be repeated a week later.

The Apple Curculio (*Tachypterellus quadrigibbus* Say.)—The apple curculio is a series pest of apples in Quebec and in some parts of Eastern Ontario. Like its relative the plum curculio, it thrives to best advantage in uncultivated orchards and also where the orchard surroundings afford it favourable hibernating quarters. So far as we are aware it is of no importance in well cultivated orchards with clean surroundings.

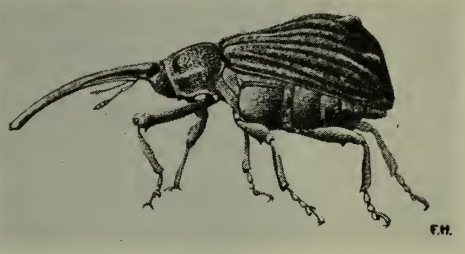


Fig. 4.—The apple curculio much enlarged (after Petch)

The apple curculio—a reddish-brown, snout-beetle about ¼-inch long—commences attacking the fruit when the petals are falling and the young fruit is just forming. The chief injury is caused by the insect puncturing the fruit for the purpose of feeding and egg-laying. The punctures stop normal growth, causing hard green areas to be formed which extend generally to the core of the apple. These hardened portions are bitter and if the fruit is badly punctured it becomes unfit for eating. The egg punctures and the feeding of the grubs cause the fruit to become dwarfed, knotty, one-sided and otherwise deformed. Most of the apples infested by the curculio grubs fall prematurely. It is important that thickets of wild crab and hawthorn in the vicinity of the orchard should be destroyed as the curculio breeds in them. Likewise, since the beetles hibernate in debris, adjoining fence rows and stone walls should be burned over and conditions in and around the orchard made as clean as possible. Spraying with poisons, *e.g.* 1½ pounds arsenate of lead per 40 gallons of spray mixture, will give good results if applied when the blossom buds are showing pink, after most of the petals have fallen and again, if necessary, one week later.

The Bud Moth (*Spilonota ocellana* D. & S.)—The bud moth occurs in all sections of Canada where apples are grown commercially, and annually causes considerable loss. In Nova Scotia, where it is particularly injurious, it ranks as one of the most important insect pests of the apple.

The bud moth attacks the buds, leaves and fruit. In spring the overwintering larvae—reddish-brown worms—bore into the opening buds, and both by direct injury to the blossoms and by injuring the leaves surrounding the blossoms, they may reduce the crop very materially. In late summer, worms of the new brood feed on the undersides of the foliage, and, where an infested leaf comes in contact with an apple, the worm ties the leaf with web to the apple and eats out several small holes in the surface of the fruit. The work of the bud moth on mature fruit may be readily determined by the presence of a group of small holes on a light area, the light area being caused, of course, by the leaf which was fastened to the apple.

In dealing with a severe outbreak of bud moth the trees should be thoroughly drenched, in spring when the tips of the more advanced buds have opened, with nicotine sulphate, 1½ pints in 100 gallons of bordeaux mixture or lime sulphur. Furthermore, in Nova Scotia it is recommended to spray again and to thoroughly cover the under sides of the leaves between July 18 and August 1, with 1 pint nicotine sulphate and 5 pounds hydrated lime in 100 gallons of water, or wettable sulphur, if needed.

Fig. 5.—Work of budmoth caterpillars (original).

Experience in fruit-growing areas, other than Nova Scotia, has shown that, in orchards which are well sprayed and are systematically sprayed year after year, the use of an arsenical *e.g.* 1½ pounds arsenate of lead per 40 gallons in the regular applications put on (1) just before or after the buds have burst and (2) when the blossom buds are showing pink, will prevent serious bud moth injury.

Round-Headed Apple-Tree Borer (*Saperda candida* Fab.)—This species is the most important apple tree borer in eastern Canada and, notably in the province of Quebec has been responsible for the killing of many trees, chiefly young trees.

The larvae—whitish or yellowish, footless grubs—burrow into the bark and wood mostly near the base of the trunks. Their presence is indicated by the sickly appearance of the trees and by the reddish sawdust-like castings which are pushed out from the burrows.

In Quebec, calcium cyanide converted into a thick paste with raw linseed or castor oil has proved to be a most effective remedy for the borer. The paste should be applied by means of a small paint brush to the parts of the trees where the castings are present and, for the best results, the treatment should be made in June.

It should be mentioned that the borer is of little or no importance where clean cultivation is practised.

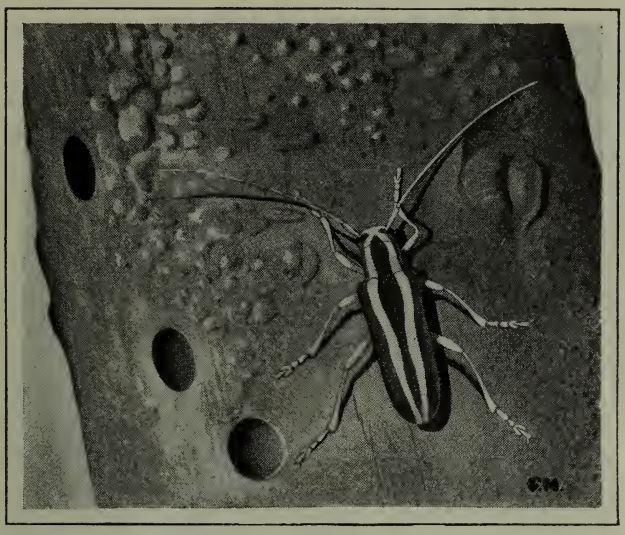


FIG. 6.—The round-headed apple tree borer (after Petch).

The Flat-Headed Apple Tree Borer (*Chrysobothris femorata* Fab.)—Apple trees, which are in a weak and unthrifty condition, due to neglect or some other cause, are sometimes attacked by flat-headed, legless, yellowish grubs, which burrow and feed between the bark and sap wood of the trunk. The borers may girdle the trunks and kill young trees.

As healthy, vigorous trees are rarely attacked by this borer, injury may be wholly or largely prevented by keeping the apple trees in a thrifty condition. In dealing with infested trees calcium cyanide paste should be applied to the affected parts of the trunks, or the borers should be cut out with a knife, care being taken not to injure the tree.

Apple and Thorn Skeletonizer (*Simaethis pariana* Cl.)—The apple and thorn skeletonizer, a recently introduced European pest, has been found in parts of Nova Scotia, Quebec, and Ontario, and, in all probability, within the next few years will spread to all the apple growing sections in Eastern Canada. The yellowish-green, black-spotted caterpillars skeletonize the leaves by eating out the green tissue, principally on the upper surface. In the case of a severe infestation, practically all the foliage, in late summer, is skeletonized, brown and dry, and appears from a distance as if it had been scorched by fire.

The skeletonizer may be readily controlled by spraying with $1\frac{1}{2}$ pounds arsenate of lead in 40 gallons of water and consequently should never be of much importance in orchards which are regularly treated with arsenicals.

The Yellow Necked and Red Humped Apple Caterpillars (*Datana ministra* Drury and *Schizura concinna* S. & A.)—Apple trees are commonly attacked in late summer by two species of black and yellow striped caterpillars which feed in colonies or clusters at the end of branches. They strip the leaves off individual limbs and sometimes defoliate young trees, but are rarely present in sufficiently large numbers to cause serious injury.

The young caterpillars may be destroyed by spraying with 1½ pounds arsenate of lead in 40 gallons of water, but, as a rule, the cheapest and simplest method of control is to hand pick and destroy the clusters of caterpillars.

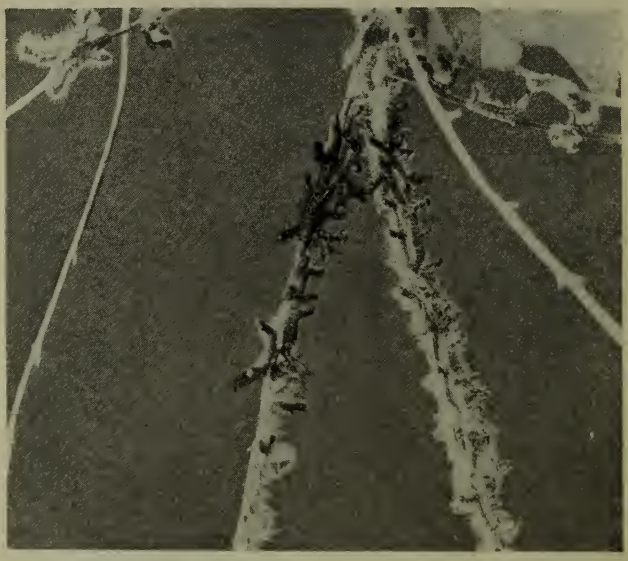


FIG. 7.—Mass of yellow-necked apple caterpillars in characteristic pose (after Hutchings).

The Fall Web Worm (*Hyphantria cunae* Drury)—In late summer and early fall large unsightly webs are commonly seen on apple and many other kinds of trees. These webs are constructed by hairy, greyish brown caterpillars which feed within them on the enclosed foliage.

FIG. 8.—The nest of the fall webworm (after Tothill)

As the fall web worm is rarely abundant in orchards, the simplest method of dealing with it is to cut off the nests and destroy the caterpillars by trampling them under foot.

Green Fruit Worms (*Xylina* spp.)—Several species of stout pale-green caterpillars frequently attack the fruit shortly after it is set and eat out holes in it. Where the attacked fruit does not fall the injury gives rise to deep and ugly scars.

Experience has shown that green fruit worm injury is of no importance on trees which are sprayed before and after the blossoms with an arsenical, *e.g.*, 1½ pounds of arsenate of lead in 40 gallons of spray mixture. The pre-blossom or pink application is particularly important in controlling these pests.

FIG. 9.—Green fruit worms attacking apples (after Slingerland).

Eastern Tent Caterpillar (*Malacosoma americana* Fab.)—Outbreaks of tent caterpillars occur periodically in Eastern Canada and in unsprayed orchards the insects commonly defoliate the trees sometimes for two or three successive years. The caterpillars, as their name indicates, construct ugly tents or webs in which they live when not feeding.

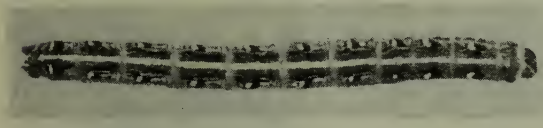


FIG. 10.—Eastern tent caterpillar (after Swaine).

Spraying the trees with an arsenical, *e.g.*, 1½ pounds of arsenate of lead per 40 gallons of water after the buds have opened will destroy the newly hatched caterpillars. This treatment should, of course, be followed by the regular applications.

White-Marked Tussock Moth (*Hemerocampa leucostigma* S. & A.)—Rather pretty, hairy caterpillars, larvae of the tussock moth, quite frequently feed on the foliage of apples and eat out shallow areas in the fruit. A brown callus forms over the injured tissue and makes the fruit scarred and ugly.

The caterpillars may be destroyed by putting on, in addition to the regular calyx spray, an application of 1½ to 2 pounds of arsenate of lead per 40 gallons of water or a fungicide two weeks after the blossoms fall. A cheaper method of control is to collect and destroy the conspicuous tussock egg masses, which are covered over with a whitish froth-like material and which are situated chiefly on the trunks and main limbs. This may be done to best advantage while pruning.

FIG. 11.—Nest of eastern tent caterpillars (after Swaine)

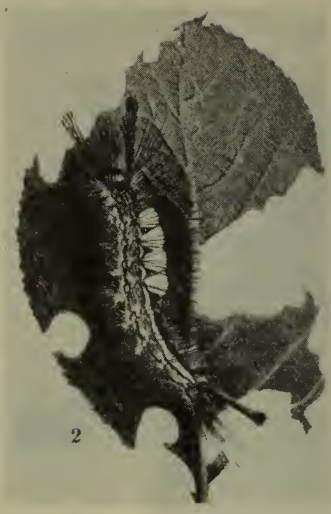


Fig. 12.—White marked tussock moth caterpillar (after Schoene)

Canker Worms (*Alsophila pometaria* Harris & *Palaeacrita vernata* Peck).—Uncared for and semi-neglected apple orchards are occasionally partially or completely defoliated in spring by two species of canker worms—slender, greenish, brownish, or blackish caterpillars, which loop in crawling and which when disturbed have the characteristic habit of dropping down on silken threads.

Canker worms may be controlled by spraying with an arsenical, *e.g.*, 2 pounds of arsenate of lead in 40 gallons of spray mixture, after the buds have burst and preferably when the blossom buds begin to show. This treatment should then be followed by the regular sprays applied before and after the blossoms.

Orchards which are carefully and systematically sprayed annually are never seriously injured by canker worms.

Case Bearers (*Haploptilia fletcherella* Fernald & *H. malivorella* Riley). Occasionally neglected apple orchards are seriously infested with small caterpillars which are protected by, and live within, small cigar and pistol shaped cases. These case bearers mine or eat out holes in the leaves and when very abundant may destroy most of the foliage.

Injury from case bearers is readily prevented by using an arsenical in the pre-blossom sprays.

Fig. 13.—Work of case-bearers (original)

The San Jose Scale (*Aspidiotus perniciosus* Comst.)—The San Jose scale has been found in British Columbia, Ontario and Nova Scotia but at the present time it is largely, if not wholly, confined to the warmer districts of Ontario, south of a line drawn from Sarnia to Toronto. Certainly this is the only section where it is well established. The failure of the scale to become established in other parts of Canada is undoubtedly due to two factors: (1) unfavourable climatic conditions such as obtain in eastern Ontario, in Quebec and in the Maritime Provinces, and (2) the vigorous eradicatory measures which have been pursued by government entomologists, particularly in British Columbia and Nova Scotia.

In the fruit-growing districts where the San Jose scale thrives, it has proved to be a very destructive pest. In addition to apples it attacks other fruit trees and many shade trees and shrubs. It occurs on all parts of the tree above ground —on the fruit where it produces reddish discolorations, on the foliage which it likewise discolours, and on the twigs, branches and trunks. On a badly infested tree, the bark may be almost completely encrusted with the scales. The injury is caused by the innumerable insects extracting the sap by means of their piercing, sucking mouthparts. This continual drain of the life juices weakens, and, if nothing is done, eventually kills the tree outright.

Fig. 14.—San Jose scale (original).

In view of the importance of the species it would be well to describe briefly the two stages which the fruit grower should be able to recognize, namely, the mature female and the black, immature stage. The full-grown female is a soft, yellow, pear-shaped insect covered with a nearly flat, circular, greyish scale about the size of a pin's head. The insect, however, may be identified with greater certainty in the immature stage—a mere speck, about $\frac{1}{16}$-inch in diameter —when the scale is black, circular, and has, as can be seen readily under a hand-lens, a central nipple encircled by a groove.

The San Jose scale can be controlled by thoroughly spraying all parts of the trees with a 3 per cent oil spray (this may be combined with bordeaux mixture) or with lime sulphur, 1·035 sp. gr. (5 gallons of commercial lime sulphur in 35 gallons of water). The general practice should be to make the application in spring just before the buds burst. Old neglected trees should be carefully pruned and the rough bark should be scraped off the trunks and large limbs before spraying. It cannot be too strongly emphasized that in combating the scale, it is essential to use sufficient material and sufficient care to wet all parts of the tree thoroughly with the spray mixture.

Oyster-shell Scale (*Lapidosaphes ulmi* Linn.)—The oyster-shell scale occurs in all the fruit-growing provinces of Canada. In Nova Scotia, Quebec and Ontario, it has been recognized for a long time past as one of the most common pests of the orchard, but in British Columbia it has only become of importance in the commercial orchards of the Okanagan within recent years.

It attacks a wide range of trees, bushes and shrubs, but is most injurious to the apple. It infests the trunks, branches and twigs, and sometimes occurs on the fruit. While not so destructive as the San Jose scale, it seriously weakens trees, kills branches and in this way materially reduces the crops. Occasionally badly infested young apple trees succumb to the attack.

Fig. 15.—Oyster-shell scale (author's illustration).

The oyster-shell scale can be readily distinguished from the San Jose scale and other orchard scale insects by the following characteristics: The scale or covering of the mature female is about $\frac{1}{8}$-inch long, is dark brown in colour and in outline resembles a long, narrow oyster shell.

In commercial apple orchards where spraying is regularly practised, experience has shown that the following treatment will readily control the oyster shell scale: For the dormant or delayed dormant application spray annually with lime sulphur 1.035 sp. gr. (5 gallons of commercial lime sulphur to 35 gallons of water) until the pest has been subdued. This application may be put

on any time in the spring previous to the bursting of the buds, but the general practice should be to apply it immediately before or as the buds are bursting, in view of the necessity of spraying at this stage for other purposes. For the calyx application, use 1 gallon of commercial lime sulphur to 40 gallons of water in combination with arsenate of lead. This spray applied after the blossoms fall, in addition to controlling codling moth and apple scab, is of value in combating the oyster shell scale, as it destroys many of the newly hatched young. In dealing with a severe infestation add nicotine sulphate $\frac{3}{8}$ pint per 40 gallons to the calyx spray mixture and delay the application for a few days.

Apple Aphids (***Anuraphis roseus*** Baker and ***Aphis pomi*** DeG.)—Apple trees are commonly attacked by two species of aphids or plant lice, namely, the rosy apple aphis, which is rosy or purplish in colour and the green apple aphis, which is green in colour. These insects cluster on the undersides of the leaves and on the tender shoots, and by means of their piercing sucking mouthparts, extract the sap. Their feeding activities cause the foliage to become distorted, and in extreme cases, to turn brown and die, and what is more serious, the abstraction of sap impairs the vigour of the trees, and hence their fruitfulness. The aphids also seriously injure the fruit by dwarfing and staining it.

Fig. 16.—Aphids on apple (original)

The rosy apple aphis confines its work primarily to the inner and lower parts of the trees, and by feeding on the leaves adjacent to the fruit clusters and on the fruit itself, it produces malformed apples, which do not become thinned out during the "June drop," and hence form clusters of dwarfed, deformed and unmarketable fruit.

The green apple aphis feeds mainly on the tender terminal shoots and on water sprouts. While it may deform apples, it causes much more important injury by seriously staining and smutting the fruit with honey-dew—a sweet sticky material, which the insect excretes in copious amounts and in which a sooty fungus grows. Fruit on trees, which are badly infested with green aphis late in the season, may be literally black with honey-dew fungus.

Recommendations for the control of apple aphids are as follows: In orchards where the rosy aphis is troublesome nearly every year, spray, as the fruit buds are on the point of bursting, with nicotine sulphate $\frac{3}{8}$ pint to 40 gallons lime sulphur. In order to obtain satisfactory results from this application it is essential to use good pressure and liberal amounts of material. Each tree, before passing on to the next, should be sprayed from all angles, so that the leeward and under sides of the buds will be as well coated as the windward and upper sides.

If the green aphis at any time of the season become abundant thoroughly spray the undersides of the leaves with $\frac{3}{8}$ pint of nicotine sulphate and 2 pounds

of soap per 40 gallons of water, or dust with nicotine dust. Also cease cultivation at once with the object of hardening the succulent growth on which the aphis thrives.

Green Apple Bug (Lygus communis Knight)—The green apple bug, an insect which closely resembles the tarnished plant bug, is a very destructive pest of apples in the Maritime Provinces and is occasionally injurious in Ontario.

The bug punctures and feeds on foliage, blossoms and fruit. Blossoms are attacked freely as soon as they appear and as a result shrivel up and die. The feeding activities of the insect on the young apples cause them to drop or, where they persist, to develop into scarred and gnarled fruit.

For the control of this pest, nicotine sulphate at the rate of 1 pint per 100 gallons should be added to the mixtures used for the pre-blossom and calyx sprays, and the trees should be literally drenched with spray.

The Apple Red Bug (*Lygidea mendax* Reut.)—In addition to the green apple bug several other species of plant bugs attack the apples and among them the apple red bug is the most troublesome, in Ontario, at least.

By puncturing the young fruit, this insect is responsible for two types of injury on mature apples, viz: (1) the feeding punctures which penetrate to the core give rise to deep pits in the fruit and (2) punctures made after the apple is too large for the insect to reach the core and when the fruit is growing rapidly give rise to irregular russet scars.

This species may be controlled by thoroughly drenching the trees after the blossoms fall, with nicotine sulphate combined with the mixture used for the calyx application.

The European Apple Sucker (*Psyllia mali* Schmidberger)—This recently introduced apple pest occurs only in the Maritime Provinces.

Fig. 17.—European apple sucker (after Dustan).

The flat, oval nymphs suck the juices from the blossoms, thus injuring the "set" of fruit; they also reduce the vigour of the trees by feeding at the axil of the leaves, in severe cases causing partial defoliation. The presence of the

sucker in an orchard may be detected in late spring and early summer by the globules of honey-dew, a sweet sticky liquid, which the nymphs excrete and by which they are surrounded.

For the control of this pest, nicotine sulphate, 1 pint in 100 gallons of a spray mixture, should be applied just before the blossoms open.

European Red Mite (*Paratetranychus pilosus* C. & F.)—The European red mite occurs in the Maritime Provinces, in all the fruit growing districts in Ontario, and it also has been found in British Columbia. In addition to the apple it infests all our common fruit trees.

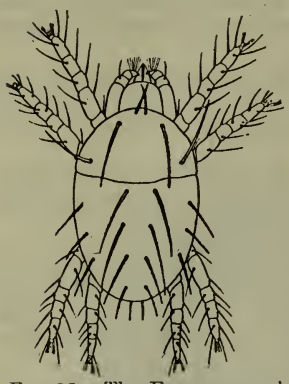


Fig. 18.—The European red mite very much enlarged (author's illustrations).

The mite, which closely resembles the red spider, attacks both sides of the foliage, punctures the tissue and withdraws the plant juices. In the case of a severe infestation the leaves turn a dusty brown and are largely functionless. The injury to the foliage naturally robs the tree of vigour and dwarfs and degrades the fruit.

The most effective method of combating the mite is to apply a 3 per cent oil spray before the buds burst. It should be mentioned, however, that in orchards which are sprayed regularly and thoroughly with lime sulphur, experience has shown that, except in rare cases, no special treatment is necessary to prevent serious mite injury.

The Blister Mite of Apple and Pear (*Eriophyes pyri* Pgst.)—In recent years the blister mite of apple and pear has been of minor importance in Eastern Canada, but in British Columbia it has been responsible for serious damage to apple orchards.

The mites—very minute creatures, practically invisible to the naked eye—burrow through the leaf and feed inside, giving rise to small blisters which at

Fig. 19.—Work of blister mite on apple leaves (original).

first are pale greenish, and later on turn brown. Badly blistered leaves either fall prematurely or where they persist, their efficiency in manufacturing food is so impaired that the trees are seriously weakened.

Experience in Ontario has shown that the mite may be reduced to insignificance by spraying thoroughly with lime sulphur 1-9 any time in the spring before the buds burst. In British Columbia a strictly dormant application, that is before any bud development has started, is necessary and for this lime sulphur 1-15 should be used.

Buffalo Tree Hopper (*Ceresa bubalus* Fab.)—Young apple trees and nursery stock are sometimes seriously damaged by the Buffalo tree hopper depositing eggs in the young wood. For the reception of the eggs the insect makes two curved incisions close together and opposite each other in the bark. The tissue between the two slits dies and a more or less oval scar is produced which continues to enlarge for several years. Where the hopper is abundant the upper and lateral sides of the smaller limbs, and sometimes the trunks of the young trees may be more or less covered with these ugly oviposition scars. Badly attacked trees are dwarfed and weakened and consequently are rendered more liable to winter injury.

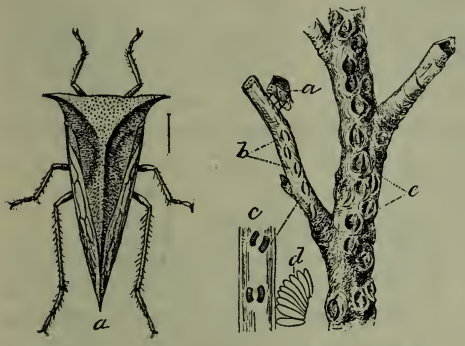


Fig. 20.—Buffalo tree hopper; a, adult enlarged and natural size; twig of apple showing recent egg punctures at b; c, bark reversed with eggs in position; d, single row of eggs—enlarged; e, wounds of two or three years standing on older limbs (after Marlatt).

A simple and effective method of preventing tree hopper injury is to keep down the weeds, on which the immature hoppers feed, by early and thorough cultivation in and around the orchard. Trees weakened by the insect should be stimulated by judicious pruning, cultivation and the use of fertilizers.

INSECTICIDES

Arsenate of Lead.—1½ pounds per 40 gallons. This is the best general purpose arsenical as it may be used with water alone or in combination with lime sulphur or bordeaux mixture. It is the only poison recommended for codling moth control.

Arsenate of Lime or Calcium Arsenate.—1 pound per 40 gallons. This is considerably cheaper than the arsenate of lead but cannot be used with safety in water alone, nor is it satisfactory for codling moth control. When combined with lime sulphur 3 to 5 pounds of hydrated lime per 40 gallons of spray should be added.

Commercial lime sulphur.—This is used at the rate of 1 gallon to 7 gallons of water for the control of scale insects and 1 gallon to 40 or 50 gallons of water for other purposes.

Bordeaux Mixture.—(See page 55.)

Sulphur and Bordeaux dust mixtures.—Two types of dust mixtures are used to a considerable extent for the control of biting insects and fungus diseases. One type is composed of superfine sulphur and arsenate of lead (generally 90-10) and the other of dehydrated copper sulphate, calcium arsenate and hydrated lime (commonly 12-8-80). These mixtures are applied by means of a power blower or duster at the rate of 40 to 90 pounds per acre depending on the size

of the trees. To be most effective, dusting should be done when the air is calm and for the copper sulphate or bordeaux dust particularly, it is desirable to have the foliage damp.

Nicotine Sulphate.—Several 40 per cent nicotine sulphate preparations are on the market and are generally used at the rate of $\frac{3}{4}$-1 pint to 100 gallons of spray. They may be combined with any orchard spray. When used alone 4 pounds of soap should be added to every 100 gallons of spray.

Nicotine Dust.—Contact dust preparations, made by impregnating hydrated lime or some other superfine material with nicotine, are sold by different commercial concerns for combating sucking insects. These dusts should be applied under calm and warm conditions.

Home-made Lubricating Oil Emulsions.—The oil spray formula and the method of emulsification most commonly used are as follows:

	3%	4%	8%
Lubricating oil*	3 gallons	4 gallons	8 gallons
Water	3 gallons	4 gallons	8 gallons
Copper sulphate (bluestone)	6 ounces	8 ounces	16 ounces
Fresh hydrated lime	6 ounces	8 ounces	16 ounces

When diluted in water to 100 gallons, the above amounts of stock emulsion make 3 per cent, 4 per cent and 8 per cent sprays respectively.

Method of Emulsifying.—Place a container with the oil in it alongside the spray outfit. Dissolve the bluestone in one-half the amount of water, and lime in the other half. Pour the bluestone solution and then the lime-water into the oil and stir. Take the suction hose out of the tank and put it into the oil mixture, start the engine, and under high pressure pump the mixture back into itself through the gun until all the oil is properly emulsified. While this is being done, the tank should be filled with water. When the tank is full and all the oil emulsified, the emulsion should be pumped into the tank through the gun.

In the case of a spray machine with no suction hose, sufficient material for one day's spraying should be emulsified in the tank, and the correct amount of emulsion for a tank of spray should be run off into each of several containers.

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* Any lubricating oil with characteristics approximately the same as the following may be used.

Gravity at 60° F.	24 to 26 A.P.I.
Flash Point (open cup)	360° F. (minimum)
Viscosity at 100° F.	170 to 220 seconds (Saybolt)
Volatility (loss at 105-110 C. after 4 hours)	0.41 per cent.
Pour and Solid	40°/35° F.

IMPORTANT DISEASES OF THE APPLE

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The apple is subject to certain fungus, bacterial and non-parasitic diseases, all of which are more or less important to the commercial grower. A short description of the more important diseases to be encountered by the orchardist is included here to aid him in successfully combating disease in the orchard.

APPLE SCAB

Undoubtedly the most important disease is Apple Scab. This disease occurs everywhere the apple is grown commercially and necessitates spraying practices in order to insure profitable returns. The losses to the apple crop due to the presence of scab amount annually to large sums of money. The losses which are most apparent to the grower are those resulting from fruit infection and evidenced by the size of the cull pile. There are other losses caused by this disease, however, which are generally overlooked by the growers. These may be mentioned as:

1. Reduction in size of fruit.
2. Dropping of infected blossoms and consequent reduction of crop.
3. Poor keeping quality of infected fruit.
4. Defoliation due to severe leaf infection and impairment of vigour.

Much of the loss caused by the scab disease can be prevented by a knowledge of the life history of the causal organism and the climatic conditions which favour its development combined with timely and thorough spraying practices.

SYMPTOMS OF THE DISEASE

The Scab fungus attacks the leaves, blossoms and fruit and less commonly, the twigs. On the leaves the fungus appears first on the lower surface in the form of dark, olivaceous velvet-like spots, irregular in outline. Later, similar spots may appear on the upper surface. The blossom parts may become infected and show typical greenish lesions on the calyx and pedicels. Where infection of the base of the calyx takes place the unsightly, worthless, deformed and cracked apple develops. Blossom infection is usually followed by the dropping of the blossom or young fruit.

On the fruit, the scab spot is conspicuous and familiar to every grower. The small spots on the fruit have a typical whitish margin with greenish centre. The spots may enlarge and often coalesce and form unsightly scars. This results in a lop-sided, often cracked and deformed fruit. "Pink Rot" often develops around the edges of scab spots if the fruit is stored under warm, moist conditions.

LIFE-HISTORY OF FUNGUS

The fungus which causes scab overwinters on the leaves which fall to the ground. During the fall and winter months the fungus grows slowly and forms fruiting bodies known as perithecia. These may be detected with the aid of a hand lens as small, black pimple-like growths over the surface of the leaf. They are produced in great abundance and from these perithecia comes the source

of primary infection in the spring. Generally about the time the buds are bursting, the fungus matures its seed (ascospores) within sac-like structures enclosed in the perithecium. These ascospores are forcibly ejected into the atmosphere during periods of precipitation and since they are quite minute they are readily carried by air currents to the trees. The discharge of ascospores from the perithecia may commence when the buds are bursting and continue intermittently on wet days until well after full bloom. These ascospores are capable of infecting the unfolding leaves and blossoms and under conditions of moisture will germinate and penetrate under the cuticle of the leaf or blossom and cause the typical scab lesions which appear in ten days to two weeks. These primary infections caused from the ascospores result in the production of large numbers of summer spores termed conidia, which are easily dislodged from the surface of the spots and carried from one place to another by wind-borne rain. These conidia are capable of germinating under favourable conditions of moisture and cause further infections throughout the season. There is, therefore, practically a continual source of infection present in the orchard from the time of primary ascospore discharge. This fact adds to the difficulty of control. In the autumn when the leaves fall to the ground the fungus begins to develop the winter stage and produce the perithecia and ascospores for the following spring. In this way the life cycle is completed.

The scab fungus is an early season, cool weather parasite which develops under wet and humid weather conditions. The development of scab is arrested to a considerable degree during midsummer when the weather is hot and prolonged rainy or humid conditions are rare. Towards fall with the return of cooler weather and more frequent rains, the possibility of late infections is occasionally of serious importance.

PREVENTION

To prevent scab it is necessary to apply spray materials to the developing leaves and fruit at different intervals during the growing season. It is seen from the life history of the fungus that the perithecia mature their ascospores generally at the time the buds are bursting and the first tissue is exposed. It is necessary therefore to protect this unfolding tissue against primary infection from the ascospores by a spray application at this time. A second application is applied when the blossom buds are showing pink and separated in the cluster. At this time considerably more leaf tissue and the individual blossom stems have been exposed to infection and an application at this time gives these parts protection. The "calyx" spray or third application is applied when all, or nearly all, the petals have fallen. This spray gives protection to the young apples as well as giving added protection to the foliage from which rains may have washed off considerable of the previous applications. A fourth application is recommended three weeks after the calyx spray. This spray gives protection to the small apple as well as the foliage. In certain seasons it may be necessary to apply a late application in August if weather conditions are cool and moist.

Thoroughness in spraying is absolutely essential if good results are to be obtained. Every part of the fruit or foliage should be thoroughly covered. Special attention should be paid to reaching the tops and innermost parts of the trees. It is helpful to spray with the wind, applying the spray as a fine mist and under a 200 to 250-pound pressure. It sometimes happens that the wind does not change to allow of spraying the far side of the trees. In this case it is necessary to drive into the wind and spray at right angles to the wind from both sides of the trees.

Of equal importance is timeliness of the application. The early sprays are timed in order to give the unfolding leaf and blossom parts fungicidal protection against the ascospores being discharged from the fallen leaves and later

from the conidia, arising from the primary infection. The exact time of application may vary somewhat one year to another with the weather conditions but the main object is to protect the developing tissues by a covering of spray material. It should be mentioned that ascospores are discharged and infection can take place only under wet conditions and therefore applications should be made previous to rains. Damage may result if applications are delayed on account of threatening weather.

Any cultural practice which might be adopted to turn under the overwintered leaves early in the season would be very helpful in reducing the amount of possible infection by destroying the source of spring infection. The ultimate success in the control of scab on the fruit is dependent on the effectiveness of preventing the primary infection which takes place between the early dormant stage and the calyx period.

SPRAY MATERIALS

Two materials are in common use for spraying of apples:

1. Lime sulphur.—Concentrated lime sulphur (Specific gravity 1.32) is commonly used at the strength of one gallon concentrate to 40 gallons of water, (specific gravity 1.008). This strength is applied for the first three applications. For subsequent sprays the strength used is one gallon concentrate to 50 gallons of water (specific gravity 1.006). Arsenate of lime or arsenate of lead poisons as well as nicotine sulphate may be added to control insects. Three pounds of hydrated lime are added to 40 gallons of mixture when the arsenicals are used.

Lime sulphur concentrate may vary in strength from a specific gravity 1.24 to 1.33. It is advisable to test the strength by a hydrometer in order to determine the proper amount to use to secure the strength required. For example if the solution tests 1.32 and a strength of 1.008 is desired divide the decimal of the solution by the decimal of the solution required which equals the dilution necessary. In the example cited, one gallon of concentrate would be diluted to 40 gallons with water.

2. Bordeaux Mixture.—This material consisting of 3 pounds copper sulphate (bluestone), 6 pounds hydrated lime and 40 gallons of water is used less generally than lime sulphur. It can only be used for the first and second application. There is danger of russeting the fruit if this material is used for the later sprays.

SPRAY CALENDAR FOR APPLES

Application	Stage	——
1. Early leaf and pre-pink	Buds burst exposing blossom clusters and ¼ to ½ green leaf tissue.	Lime sulphur 1–40 gals. or sp. gr. 1·008. Bordeaux 3–6–40.
2. Pink spray	When blossom buds are showing pink and separating from clusters.	Lime sulphur 1–40 gals. or sp. gr. 1·008. 3 pounds hydrated lime, 1½ pounds arsenate of lead. or Bordeaux 3–6–40. 1½ pounds arsenate of lead.
3. Calyx	When most of the petals have dropped and before calyces close.	Lime sulphur 1–40 sp. gr. 1·008. 3 pounds hydrated lime, 1½ pounds arsenate of lead.
4. Three weeks	2 to 3 weeks later, depending on weather conditions.	Lime sulphur 1–50. sp. gr. 1·006.
5. Extra applications	Applied when weather conditions are threatening, prolonged wet conditions.	Lime sulphur 1–50. sp. gr. 1·006.

BLACK ROT CANKER, BLACK ROT AND LEAF SPOT
Physalospora Malorum Shear

A second disease which attacks the apple, particularly in somewhat neglected orchards, is Black Rot. The fungus causing this disease affects the trunks, branches, leaves, fruit, and rarely the twigs. The greatest damage is caused by the cankers produced on the trunk and larger limbs as these cankers may result in girdling the affected part and causing the death of the distal parts.

Symptoms

On the leaves circular brown spots with purplish borders are produced. The spots may show concentric markings due to the enlargements of the spots. From this condition the spots have earned the name of "frog-eye spot". The fruit rot is not in evidence until a few weeks before maturity or later as a storage rot. It is apparent first as a small brown spot which enlarges and may involve the entire fruit. Later, the brown colour turns black and the surface becomes covered with minute black pimples which are the fruiting bodies of the fungus.

On the trunk and larger limbs the disease is evidenced by reddish brown discolorations of the bark which later become sunken or depressed. Lesions may remain small or enlarge to a length of a yard or more and finally girdle the affected part. Cankers may show only a superficial roughening of the bark while in other cases the bark is killed to the cambium and the underlying wood may be stained and cracked. Minute black fruiting pustules may be found abundantly over the bark of the cankers.

Life History of Fungus

The fungus winters over in the form of dormant fungus threads or mycelium in the cankers and as immature spores within the fruiting bodies, which appear so abundantly over the surface of affected parts as little black pimples. These spores are discharged in spring and early summer and form the source of new infections. A second spore form is also formed on the cankers, although much less commonly, and which also serves to winter the fungus over. From the dormant mycelium, growth is renewed the following spring and cankers in this way enlarge one year to another.

The causal fungus is a wound parasite and gains entrance to the host through wounds from various causes. Winter injury and sunscald are predisposing factors and the parasite commonly gains entrance following this form of injury. Carelessness in cultivation, pruning and picking of fruit often cause injuries through which the parasite may enter the host.

Control

Since winter injury and sunscald are predisposing factors, growers should avoid planting varieties which may not be hardy in their district. Cultural practices should be adopted so that the trees will enter the dormant season with properly ripened wood. Care should be taken to avoid wounding the trees as much as possible.

Cankers should be cut out with a draw-knife, care being taken to cut back to healthy wood and leaving the edges of the wound smooth. The wounds should be washed with concentrated lime sulphur or bluestone 1 pound to 10 gallons water and painted with white lead or coal tar. It may be advisable to prune out badly cankered limbs if this can be done without unbalancing the tree too much. All such prunings and scrapings from cankers should be burned as they carry the infectious fungus spores.

Spray the trees as recommended for the prevention of apple scab, with particular attention to the first spray and see that the trunks and limbs are well covered with spray material.

FLY SPECK OR SOOTY BLOTCH

Gloeodes pomigena (Schw.) Colby)

This is a disease of importance in seasons when the weather is exceptionally wet during late summer. It is troublesome particularly on Spy and Greening varieties.

SYMPTOMS

Irregular sooty blotches are present on the surface of the fruit. These blotches may coalesce and involve large areas of the fruit. The disease may also be evident by minute dark coloured specks over areas of the fruit. The characteristic blotches and specks are superficial and although they render the fruit less attractive, the flesh is not injured.

CONTROL

Prune the trees so that plenty of light and good air drainage is secured. This will allow the foliage to dry rapidly after heavy rains and dews. Spray as recommended for apple scab, applying the August spray if weather conditions are wet.

FIRE BLIGHT OR TWIG BLIGHT

Bacillus amylovorus (Burrill)

This is a bacterial disease which affects the apple, pear and quince, and in favourable seasons, may be quite destructive to these hosts, particularly to the pear. In the case of apple the causal organism does not spread and involve the larger limbs and trunks as readily as in the pear. For the most part the disease is confined to the twigs; although cankers on the limbs are found. They are largely the result of infection of suckers and watersprouts growing from these parts.

SYMPTOMS

Affected twigs are noticed to wilt and the foliage becomes dry, shrivelled and discoloured a reddish brown. This dead foliage often remains on the twigs throughout the season and during the winter. Blossoms may become blighted and remain clustered to the twig. The disease may spread through the twigs or suckers and cause cankers on the limbs, or main trunk. This cankered area shows a brownish or purplish discoloration, somewhat sunken, sometimes cracked and blistered. A gummy exudate may exude from these cankered areas. Such infections usually live for only a few weeks and then die.

CONTROL

Do not encourage great growth and succulence of trees because this condition favours the disease. With susceptible varieties, grow the trees in a sod mulch or else lessen the amount of cultivation and of fertilizers. Remove watersprouts and suckers to prevent the disease forming cankers on the limbs. The disease in the apple generally dies out before it progresses very far and the removal of blighted twigs in large trees is impracticable and not so important as it is in the pear. The diseased twigs should be removed during the winter.

Certain varieties, notably the Alexander, King, Gravenstein and Greening are more subject to the blight than others. These varieties should never be planted alongside a pear orchard.

BALDWIN SPOT, STIPPEN OR BITTER PIT

This is a disease entirely confined to the fruits and is not of an infectious nature.

SYMPTOMS

As the fruit becomes half grown or as it approaches maturity, small sunken, dark spots appear on the surface of the fruit. Below the spots the flesh is dead and brown and frequently similar brown spots and streaks are scattered throughout the interior of the fruit. Sometimes the fruit may appear as apparently normal and the stippen spots develop in storage.

CAUSE

The disease is caused by a disturbed water relation. The predisposing factors to this condition are:—

1. Soils of poor physical condition especially those that are low in humus and have a poor water holding capacity.
2. By heavy pruning or a system of pruning which causes the fruit to be produced on main limbs rather than on well-distributed laterals.
3. Extreme variation in the water supply to the trees during the growing season which tend to check and stimulate, alternately, the growth of the fruit.
4. Trees which produce a light crop of over-sized fruits.

CONTROL

Very little can be done to overcome this disease. However, any practices which may be adopted to promote a uniform growth from early spring to the ripening period will minimize the disease. Such practices include:

1. Increasing water holding capacity of soil by use of manure or cover crops.
2. Cultivation or mulching to ensure satisfactory moisture conditions throughout the growing season.
3. Proper pruning so that the crop is evenly distributed over the tree.

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